

SEAMANSHIP TECHNIQUES

2nd edition

By the same author

Navigation for Masters ISBN 185609 147 3

Marine Survival and Rescue Systems ISBN 185609 1279

An Introduction to Helicopter Operations at Sea ISBN 185609 1686

Cargo Work (Kemp & Young) Revised ISBN 07506 3988 1

Seamanship Techniques (The Command Companion) Vol. III ISBN 07506 4443 5

Anchor Practice: A Guide for Industry ISBN 185609 2127

SEAMANSHIP TECHNIQUES

SECOND EDITION



PART ONE: SHIPBOARD PRACTICE

PART TWO: SHIP HANDLING

D. J. HOUSE

BUTTERWORTH
HEINEMANN

Oxford Auckland Boston Johannesburg Melbourne New Delhi

Butterworth-Heinemann
Linacre House, Jordan Hill, Oxford OX2 8DP
225 Wildwood Avenue, Woburn, MA 01801-2041
A division of Reed Educational and Professional Publishing Ltd

 A member of the Reed Elsevier plc group

First published as two volumes 1987
Volume 1 first published as paperback 1989
Volume 2 first published as paperback 1990
Single volume edition 1994
Reprinted 1995, 1997, 1998, 1999 (twice)
Second edition 2001

© D. J. House 1987, 1994, 2001

All rights reserved. No part of this publication may be reproduced in any material form (including photocopying or storing in any medium by electronic means and whether or not transiently or incidentally to some other use of this publication) without the written permission of the copyright holder except in accordance with the provisions of the Copyright, Designs and Patents Act 1988 or under the terms of a licence issued by the Copyright Licensing Agency Ltd, 90 Tottenham Court Road, London, England W1P 0LP. Application for the copyright holder's written permission to reproduce any part of this publication should be addressed to the publishers

ISBN 0 7506 5231 4

British Library Cataloguing in Publication Data

House, D.J.

Seamanship techniques. – 2nd ed.

1. Seamanship

I. Title II. Shipboard practice III. Ship handling

623.8'8

Library of Congress Cataloguing in Publication Data

A catalogue record for this book is available from the Library of Congress

www.bh.com/engineering

Typeset in Replika Press Pvt Ltd. 100% EOU, Delhi 110 040
Printed and bound by Replika Press Pvt Ltd. 100% EOU, Delhi 110 040



FOR EVERY TITLE THAT WE PUBLISH, BUTTERWORTH-HEINEMANN
WILL PAY FOR BTCV TO PLANT AND CARE FOR A TREE.

ABBREVIATIONS



(Marine abbreviations used in this text and within the marine industry)

ABS	American Bureau of Shipping	DSC (ii)	Digital Selective Calling
A.C.	Alternating Current	DWT (DW)	Deadweight
AHV	Anchor handling vessel	ECDIS	Electronic Chart Display Information System
AIS	Automatic Identification System	EFSWR	Extra Flexible Steel Wire Rope
AMVER	Automated Mutual Vessel Rescue system	ENC	Electronic Navigation Chart
ARCS	Admiralty Raster Charts	EPIRB	Emergency Position Indicating Radio Beacon
ARPA	Automatic Radar Plotting Aid	ETA	Estimated Time of Arrival
AUSREP	Australian Ship Reporting system	FRC	Fast Rescue Craft
B.S.	Breaking Strain	FSM	Free Surface Movement
BV	Bureau Veritas	FSWR	Flexible Steel Wire Rope
CABA	Compressed Air Breathing Apparatus	FWA	Fresh Water Allowance
CES	Coast Earth Station	GHz	gigahertz
CG	Coast Guard	GM	Metacentric Height
CMS	Constantly Manned Station	GMDSS	Global Maritime Distress and Safety System
CO ₂	Carbon Dioxide	GMT	Greenwich Mean Time
C of B (B)	Centre of Buoyancy	GPS	Global Positioning System
C of G (G)	Centre of Gravity	GT (g.t.)	Gross Tons
CPA	Closest Point of Approach	GZ	Righting Lever
CPP	Controllable Pitch Propeller	HF	High Frequency
CQR	Chatham Quick Release	HLO	Helicopter Landing officer
CRS	Coast Radio Station	HMS	Her Majesty's Ship
CS	Coast Station	HMSO	Her Majesty's Stationery Office
DC	Direct Current	HRU	Hydrostatic Release Unit
DGPS	Differential Global Positioning System	HSC	High Speed Craft (code)
DNV	Det Norske Veritas	IAMSAR	International Aeronautical and Maritime Search and Rescue Manual
DRHQ	Divisional Rescue Head Quarters	ICAO	International Civil Aviation Authority
DSC (i)	Dynamically Supported Craft (hydrofoils)		

ICS	International Chamber of Shipping	NUC	Not Under Command
IHO	International Hydrographic Office	NVE	Night Vision Equipment
IMDG	International Maritime Dangerous Goods Code	OiC	Officer in Charge
IMO	International Maritime Organisation	OOW	Officer of the Watch
ISM	International Safety Management	OSC	On Scene Co-ordinator
ITU	International Telecommunications Union	P/A	Public Address System
KB	Measured distance between the keel and the ships centre of buoyancy	RN	Royal Navy
KG	Measured distance between the keel and the ships centre of gravity	RNR	Royal Naval Reserve
kg	kilogram	RoPax	Roll on/Roll off + Passengers
kHz	kilohertz	RoT	Rate of Turn
kJ	kilo Joule	Ro-Ro	Roll on, Roll off
KM	Measured distance between the keel and the ships metacentre	rpm	Revolutions per minute
kN	kilo Newton	R/T	Radio Telephone
kW	kilowatt	Rx	Receive
lbs	pounds	SAR	Search and Rescue
LBP	length between perpendiculars	SARSAT	Search and Rescue Satellite
LCB	Longitudinal Centre of Buoyancy	SART	Search and Rescue Radar Transponder
LFL	Lower Flammable Limit	SES	Ship Earth Station
LNG	Liquid Natural Gas	SOLAS	Safety of Life at Sea (convention)
LOA	length over all	SOPEP	Ships Oil Pollution Emergency Plan
LR	Lloyds Register	SPM	Single Point Mooring
LUT	Land User Terminal	STCW	Standards of Training, Certification and Watchkeeping (convention)
MA	Mechanical Advantage	SWL	Safe Working Load
MAIB	Marine Accident Investigation Branch	SWR	Steel Wire Rope
MARPOL	Maritime Pollution Convention	T.D.	Tonnage Deck
mbs	millibars	TMC	Transmitting Magnetic Compass
MCA	Maritime and Coastguard Agency	TRS	Tropical Revolving Storm
MEC	Marine Evacuation Chute	UFL	Upper Flammable Limit
MES	Marine Evacuation System	UHF	Ultra High Frequency
MGN	Marine Guidance Notice	U.K.	United Kingdom
MHz	megahertz	UKC	Under Keel Clearance
MIN	Marine Information Notice	ULCC	Ultra Large Crude Carrier
MN	Mercantile Marine	U.S.	United States
MNTB	Merchant Navy Training Board	USCG	United States Coast Guard
MoB	Man overboard	VCG	Vertical Centre of Gravity
MPCU	Marine Pollution Control Unit	VDR	Voyage Data Recorder
MRCC	Marine Rescue Co-ordination Centre	VDU	Visual Display Unit
MSI	Marine Safety Information	VHF	Very High Frequency
MSN	Merchant Shipping Notice (previous 'M' notice)	VLCC	Very Large Crude Carrier
		VTMS	Vessel Traffic Management System
		VTS	Vessel Traffic System
		W/L	Waterline
		WNA	Winter North Atlantic
		Wps	wires per strand
		W/T	Wireless Telegraphy

PART ONE



SHIPBOARD PRACTICE

CONTENTS TO PART ONE



Abbreviations	v
Preface	xiii
Acknowledgments	xiv
List of plates	xv
List of tables	xvii
1. <i>THE SHIP</i>	
Introduction	1
Terms and definitions	1
Terms and definitions concerning stability	5
Varieties of ship	6
Plate and construction terms	6
Main structural members – compensating stress factors affecting vessel	19
Stresses in ship structures	20
Loadlines	22
2. <i>ANCHOR WORK</i>	
Anchors	25
Tests on anchors	27
Marks on anchors	29
Anchor certificate	29
Chain cable tests	29
Notes on cable	30
Kenter lugless joining shackle	30
‘D’ lugged joining shackle	32
Securing and stowage of anchors	33
Securing anchor and cable	33
Steam windlass operation	34
Preparing anchor for ‘letting go’	34
Cable holders	35
Procedure for coming to anchor	36

Clearing away anchors	40
Anchor terminology	41
Watch at anchor	46
Deep water anchoring	49
Laying/carrying out anchors	49
Clearing a foul hawse	50
To weigh anchor by deck tackle	52
Anchor recovery – loss of windlass power	52
Hanging off an anchor	53
Lost anchor and re-securing of spare anchor	55
Mooring anchors	57
3. <i>ROPEWORK</i>	
Natural fibre ropes	59
Lay of rope	62
Small stuff	63
Synthetic fibre ropes	65
Bends and hitches	67
Working aloft and overside	71
Seizings	73
Ropework and cordage tools	74
Worming, parcelling and serving	75
Cordage splice	76
Whippings	77
Marrying two ropes together	78
To pass a stopper	79
Breaking out mooring rope	81
4. <i>WIREWORLD AND RIGGING</i>	
Steel wire rope	82
Steel wire rope rigging	86
Rigging fitments	91
Wire splicing	93
Stowage of wire hawsers	96
Safe handling procedures for wire rope	96
Mousing a hook or shackle pin	97
Blocks – care and maintenance	98
Blocks and tackles	100
5. <i>LIFTING GEAR</i>	
Derricks	106
Union purchase	110
Safe handling practice for derricks	112
Doubling-up procedure	113
Butterfly rig	113
Yo-Yo rig	114
Hallen universal derrick	115
Hallen container derrick	116

Velle shipshape crane	117
Heavy lift procedures	118
Cranes	121
Cranes and derricks – advantages and disadvantages	124
Derrick tests and surveys	125
Rigging of sheer legs	125
Rigging of gyn	127
Hand signals	127
Calculating stresses in derricks by empirical formula	127
6. <i>CARGO AND HATCHWORK</i>	
Conventional hatch	142
Conventional hold	145
Steel hatch cover	146
General cargo terminology	152
Duties of junior cargo officer	153
Hold preparation	154
Stowage methods	155
Cargo handling	156
Ventilation	158
Refrigerated cargoes	158
Carriage of goods in deep tanks	160
Container tonnage	162
Roll on–roll off system	162
Cargo plans	164
7. <i>BOATWORK</i>	
Parts of the lifeboat	168
Types of wood construction	171
Boat fitments	172
Totally enclosed survival craft	180
Partially enclosed boats	186
Boat rigging	188
Launching procedure	191
Taking boat away from ship's side	196
Boat recovery in heavy weather	197
Beaching lifeboat	198
Boat handling and safe procedures	200
Markings on sails	201
Sail theory	201
Sail terminology	203
8. <i>SURVIVAL CRAFT AND PRACTICE</i>	
Survival systems international	204
The Inflatable life raft	204
Launching inflatable life raft	211
Boarding raft	212
Rigid life rafts	212

The davit launched life raft	214
Additional fitments to raft	221
Abandoning ship	222
Marine evacuation system	225
Evacuation-slide launching and embarkation	225
Righting capsized life raft	227
Beaching a life raft	227
9. <i>COMMUNICATIONS</i>	
Methods employed in marine industry	245
Flag signalling terms	249
Single letter meanings – International Code of Signals	250
Signalling by International Code flags	250
Important two-letter signals	255
Sample messages employing International Code of Signals	256
Flag maintenance	256
Wearing of ensigns	257
Morse code procedure – signalling by flashlight	260
Morse code regular procedural signals	262
Morse code signalling by hand flags or arms	262
APPENDIX:	
Seaman's self-examiner	264
Efficient deck hand examination	264
Certificate of Proficiency in Survival Craft and Rescue Boats	266

PREFACE TO PART ONE



This single volume edition of general seamanship provides a comprehensive cover to the needs of marine students and serving seafarers. It is ideal for Merchant Navy Officers from Cadet rank to Master Mariner and incorporates all recent amendments to collision regulations.

In changing times the design and build of ships has altered and the needs of the professional mariner must be adapted to meet these modern times. However, old vessels do not disappear overnight and the old practices of basic seamanship are still required in all quarters of the globe. The practical seaman must adapt alongside a developing hi-tech industry and be able to improvise when the need arises.

This work takes account of many types of vessel engaged on many commercial trades and is expected to continue to be the accepted reference on general seamanship. It incorporates all the subjects required by the professional mariner, including: anchor work, rigging, cargo work, survival and boatwork, communications, search and rescue practice, watchkeeping, meteorology, marine instruments, tanker work and pollution, together with marine emergencies and ship handling.

The marine industry is demanding in nature. It absorbs not only the ships which create its very existence, but also the personalities of the professional men and women cast within its perimeter. It has been my great fortune to have made the acquaintance of a number of these professionals, without whose teaching and understanding this work could never have evolved. My personal thanks are sincerely given, especially to the following:

J. W. Riley, Lt, Cdr (SCC, RNR Retd)

Mr A. R. Ollerton, Senior Lecturer, Nautical Studies, Master Mariner,
DMS, AMBIM

Mr J. Finch, Senior Lecturer, Nautical Studies, Master Mariner
and to my wife Lucia, just for being there.

ACKNOWLEDGMENTS TO PART ONE



I would like to express my appreciation and thanks to the following for their assistance in supplying diagrams, photographs and information relevant to this work:

1. Beaufort Air-Sea Equipment Ltd
2. Bruce Anchor Ltd
3. Bruntons (Musselburgh) Ltd
4. British Ropes Ltd
5. Dunlop Ltd
6. General Council of British Shipping/MNTB
7. NEI Clarke Chapman Ltd, Clarke Chapman Marine
8. *The Motor Ship* (published by IPC Industrial Press Ltd)
9. E & FN Spon Ltd for references from *Cargo Access Equipment*
10. F. R. Fassmer & Co.
11. Stanford Maritime Ltd for references from *The Apprentice and His Ship* (Charles H. Cotter)
12. James Robertson & Sons, Fleetwood
13. HMSO – British Crown Copyright Reserved
14. Kelvin Hughes Ltd, Naval & Marine Division of Smiths Industries Aerospace
15. RFD Inflatables Ltd
16. The Welin Davit & Engineering Company Ltd
17. Macgregor & Co. (Naval Architects) Ltd
18. Watercraft Ltd – Survival Craft Division
19. Whittaker Corporation – Survival Systems Division
20. The Solid Swivel Company Ltd
21. Elkem a/s Stalog Tau
22. The Nautical College, Fleetwood – Lancashire Education Committee
23. Additional artwork by A. Benniston
24. *Creative Ropework* (published by G. Bell & Sons Ltd) by Stuart E. Grainger
25. C.M. Hammar Handels A.B.

PLATES TO PART ONE



1. Roll on–roll off ferry	10
2. Modern tanker	10
3. Modern high speed passenger ferry engaged on the Irish sea trade	11
4. Hydraulic windlass	35
5. Pneumatic windlass	36
6. Single barrel hydraulic mooring winch	36
7. Double barrel anchor-handling/towing winch	37
8. Hydraulic capstans	37
9. Anchor a-cockbill	41
10. Bruce (mooring) anchor	57
11. Gooseneck and derrick heel block arrangement	107
12. Union purchase	109
13. Velle crane	117
14. Heavy lift derrick	119
15. Deck crane	123
16. Conventional hatch	142
17. Booby hatch access to hold	144
18. Single pull Macgregor steel hatch	149
19. Steel hatch cover	149
20. Chain pull steel hatch covers	149
21. Rack and pinion horizontally stowed steel hatch covers	150
22. Hydraulic folding Macgregor steel hatch covers	150
23. Open hatchway and cargo	150
24. Roll on–roll off unit	163
25. Fore end view of tanker	165
26. Open boat in gravity davits	169
27. GRP lifeboat	170
28. Totally enclosed lifeboat on moorings	179
29. Partially enclosed rescue/lifeboat	180
30. Totally enclosed boat in davit arrangement	185
31. Survival Systems International operational at sea	205

32.	Rack stowage of inflatable life rafts	210
33.	Davit launched life raft	214
34.	Inflatable life raft	219
35.	Training with helicopter strop	235
36.	Semi-rigid inflatable	240

TABLES TO PART ONE



2.1	Proof loads for anchors	28
2.2	Types of chain cable	31
2.3	Stud link chain cable	31
3.1	Rope sizes for breaking strain of 86 tonnes	60
3.2	Resistance of ropes to corrosion	60
3.3	Rope size for West Country stopper	79
4.1	Steel wire rope	83
4.2	Formulae for breaking stresses	83
4.3	Cordage table for use with open heart thimble	93
5.1	Safe working load	111
5.2	Loading and discharging using different rigs	114
5.3	Tests on derricks	125
6.1	Cargoes carried in deep tanks	162
9.1	Examples of flag hoists	255
9.2	Tables of complements	255
9.3	Phonetic alphabet and figure spelling	260
9.4	International Morse Code	261

THE SHIP



INTRODUCTION

The art and science of seamanship has developed from the experience of maritime nations over many centuries. Sea travel has passed through the days of propulsion by oars, the discovery days of sail, through the advances of steam on to the age of oil, and finally to the atomic period of advanced technology. The art of mastering the means of transportation on water, having seen the excitement of discovering new worlds and the conquering of new boundaries, has settled for the advance of trade in all directions of the compass.

The ship, once stored and provisioned, becomes the ideal in self-sufficiency, capable of the transport of cargo, livestock, troops, passengers gas, fluids, minerals etc. The fact that the vessel provides a source of power which can cope with varying degrees of emergency and still be able to sustain itself says a lot for the developed marine industry.

The ship is equipped with such ancillary equipment as required to be able to load and offload, in a safe condition, all cargoes and passengers as the vessel is designed to accommodate. Bearing the function of the ship in mind, it is not difficult for seafarers to realise how their characters have been influenced by the independent nature of their employment. Seamanship and the ships themselves have created the spirit of adventure that turned such men as Magellan, Drake, and Nelson into more than legends.

Even in today's ships, be they of the mercantile marine or 'Men of War', the same spirit prevails, and it is hoped that this book will direct the men who man them safely into good seamanlike practices.

TERMS AND DEFINITIONS

Abeam

A bearing projected at right-angles from the fore and aft line, outwards from the widest part of the ship (Figure 1.1).

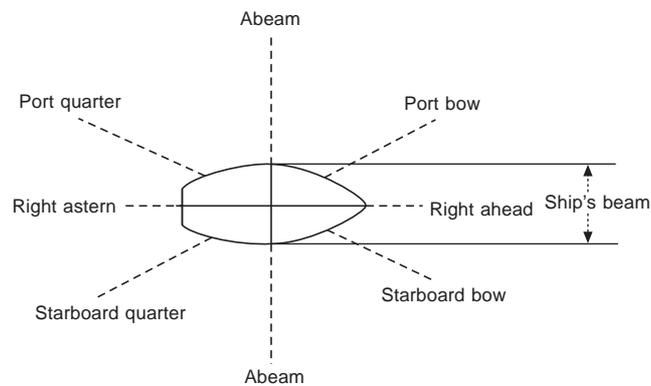


Figure 1.1 The ship in relation to its surroundings.

Ahead

'Right ahead' is the line the fore and aft line, if projected, would extend in front of the vessel (Figure 1.1). Opposite to the term 'astern', when used in relation to relative bearings. It may also be used as an engine-room order to cause the engines to turn in order to move the ship ahead.

Amidships

The middle of the vessel in both transverse and longitudinal directions. More commonly used as a helm order, when it is usually shortened to 'midships' (see 'Chapter 1', Part Two).

Athwartships

Defined as 'in a direction' from one side of the ship to the other, at right-angles to the fore and aft line.

Breadth

The maximum beam of the vessel measured from the outside edge of the shell plating on either side of the vessel is the *extreme* breadth (Figure 1.2).

The beam of the vessel measured amidships, between the inside edge of the shell plating on either side of the vessel, is the *moulded* breadth (Figure 1.2).

Camber (or round of beam)

The curvature of the deck in the athwartships direction. The measurement is made by comparing height of deck at the centre of the vessel to height of deck at the side of the vessel (Figure 1.2).

Depth

The *extreme* depth of the vessel is measured from the bottom side of the keel to the top of the deck beams, the measurement being taken at the side of the vessel.

The *moulded* depth is measured from the top side of the keel to the top of the deck beams, at the side of the vessel.

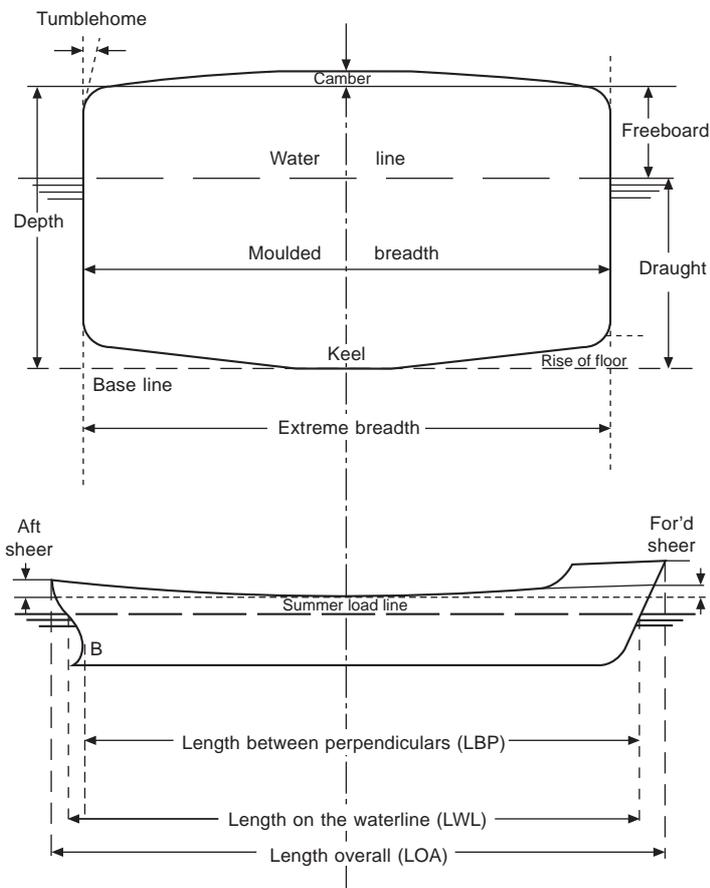


Figure 1.2 Ship's principal dimensions.

Flare

The outward curvature of the shell plating in the foremost part of the vessel, providing more width to the fo'c'sle head and at the same time helping to prevent water coming aboard.

Fore and Aft Line

An imaginary line passing from the stem to the stern through the centre of the vessel (Figure 1.3).

Freeboard

This is the vertical distance, measured at the ship's side, from the waterline to the top of the freeboard deck edge. The freeboard measurement is taken at the midships point. Deck edge is marked by a painted line 25 mm × 100 mm.

Keel Rake

The inclination of the line of the keel to the horizontal (Figure 1.4).

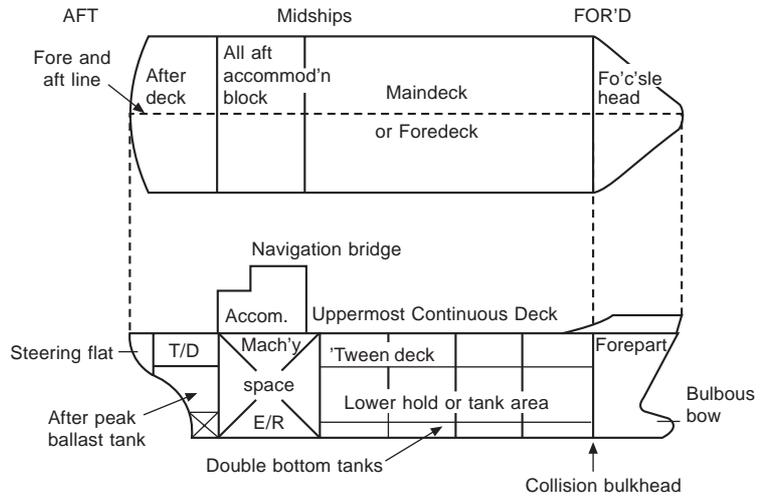


Figure 1.3 The ship in section and plan.



Figure 1.4 Keel rake.

Length between Perpendiculars (LBP)

The distance between the for'd and aft perpendiculars.

Length Overall (LOA)

The maximum length of the vessel measured from the extreme for'd point of the vessel to the extreme after point (Figure 1.2).

Perpendiculars

A perpendicular drawn to the waterline from a point on the summer load-line where it intersects the stempost is called the forward perpendicular (FP).

A perpendicular drawn to the waterline at a point where the after side of the rudder post meets the summer waterline is called the aft perpendicular (AP). If a rudder post is not fitted, then it is drawn from the centre of the rudder stock.

Rise of Floor

This is the rise of the bottom shell plating above the base line (taken from the top edge of the keel).

Sheer

This is the curvature of the deck in the fore and aft direction, measured as the height of the deck at various points above the height of the deck at the midships point (Figure 1.2).

Ship's Beam

The widest part of the ship in the transverse athwartships direction (Figure 1.1).

Stem Rake

The inclination of the stem line to the vertical.

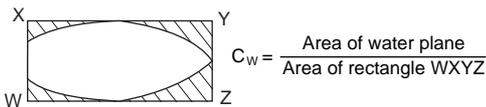


Figure 1.5 Coefficient of fineness.

$$C_w = \frac{\text{Area of water plane}}{\text{Area of rectangle WXYZ}}$$

Tonnage

The number of tonnes of cargo, stores etc. that a vessel is capable of carrying when floating at her load draught is *deadweight* tonnage.

The total quantity of water displaced by the vessel when floating at her load draught is *displacement* tonnage.

Gross tonnage is defined by the measurement of the total internal volume of the ship. It is equal to the underdeck tonnage plus the tonnage of all other enclosed spaces above the tonnage deck. Unit of measurement is 100 cubic ft, there being no metric equivalent.

Underdeck tonnage is based on the internal measurement of all the space between the ceiling or double bottom in the hold and the under surface of the tonnage deck.

Net tonnage is the remaining tonnage value after allowing for machinery, crew accommodation and working spaces have been deducted from the gross tonnage.

Tumblehome

The inward curvature of the ship's side shell plating above the summer loadline (Figure 1.2).

TERMS AND DEFINITIONS CONCERNING STABILITY

Centre of Flotation

That point in the ship's length about which the vessel will trim by the head/by the stern. In layman's terms the tipping centre of the ship, which is very rarely the exact midships point.

Coefficient of Fineness (of the water-plane area) C_w

The ratio of the water-plane area to the area of the rectangle having the same extreme length and breadth (Figure 1.5). Block coefficient of fineness of displacement is similarly applied, using the values of volume instead of area.

Displacement

The displacement of a vessel is the weight of water it displaces, i.e. the weight of the vessel and all it contains. It is the immersed volume of the ship in cubic metres \times density of the water, expressed in tonnes per cu. m. It is normal practice to regard the ship's displacement as being that displacement when at her load draught (load displacement).

The weight in tonnes of the completed vessel with boilers, if any, filled to working level with lubricating oil and cooling water, but without cargo, bunkers, stores, dunnage etc. is called the *light displacement*.

Equilibrium

A body is said to be in *stable* equilibrium (Figure 1.7) if, when slightly disturbed and inclined from its initial position, it tends to return thereto. A body is said to be in a state of *neutral* equilibrium if, when slightly

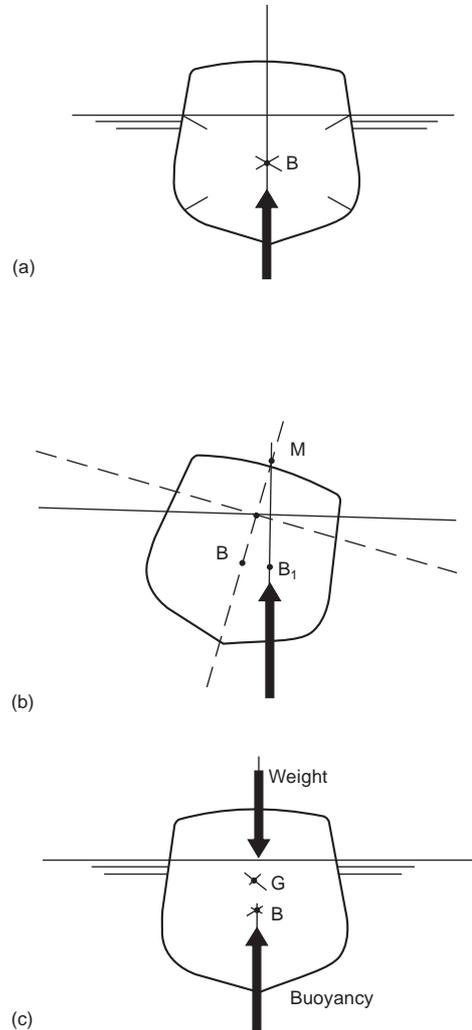


Figure 1.6

(a) *Centre of buoyancy*

The centre of buoyancy (C of B) is that point through which the resultant of all the forces due to buoyancy may be considered to act. It is the geometric centre of the underwater volume of the ship.

(b) *Transverse metacentre*

The transverse metacentre (M) is that point of intersection of a vertical line through the centre of buoyancy, in the upright position, with a vertical line through the new centre of buoyancy (B_1) in a slightly inclined position.

(c) *Forces acting on a vessel in still water*

The force of buoyancy must be equal and opposite to the forces of gravity if no vertical movement of the body is to take place. For the body to float in the upright position, both forces must act in the same vertical plane.

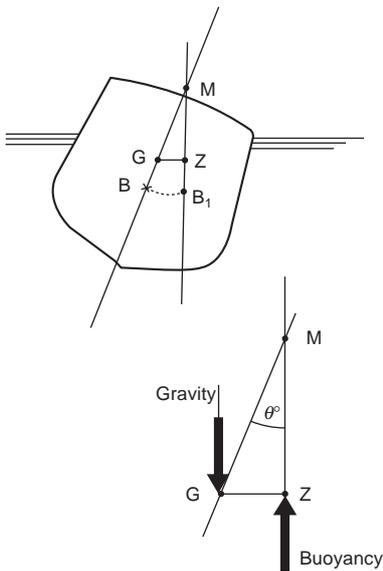


Figure 1.7 Vessel in stable equilibrium.

disturbed from its initial position, it exhibits no tendency to return thereto or to move to another new position. A body is said to be in *unstable* equilibrium if, when slightly disturbed from its initial position, it tends to move further from it.

Figure 1.7 shows a *vessel in stable equilibrium*. As the vessel heels to θ° by an external force (e.g. waves, wind), G remains in the same position and B moves to B_1 . A righting couple is formed WGZ , where W is the weight effect of the ship acting through G (due to gravity) GZ , being known as the righting lever. In triangle MGZ , $GZ = GM \sin \theta^\circ$. Therefore $W \times GZ = W \cdot GM \sin \theta^\circ$, bringing the vessel back to the upright position. This is the situation when G is below M, i.e. *when GM is positive*.

Load Deadweight

The total weight of cargo, stores, bunkers etc. when the vessel is at her loaded draught (summer loadline). It is equivalent to the difference between her load displacement and her light displacement.

Reserve Buoyancy

The buoyancy of the immersed portion of the vessel is that which is necessary to keep the vessel afloat. The buoyancy of all other enclosed watertight spaces above the waterline is therefore residual buoyancy, more commonly referred to as 'reserve buoyancy'. It must be assumed that in the case of the conventionally designed ship, if water equal to the displacement and reserved buoyancy enters the vessel, it will sink. Sufficient reserve buoyancy is necessary in all seagoing vessels in order for the ship to rise quickly, owing to the lift effect, when navigating, especially in heavy sea conditions.

VARIETIES OF SHIP

Ships come in all forms, and Figures 1.8 to 1.21 illustrate this variety. See also Plates 1 to 3.

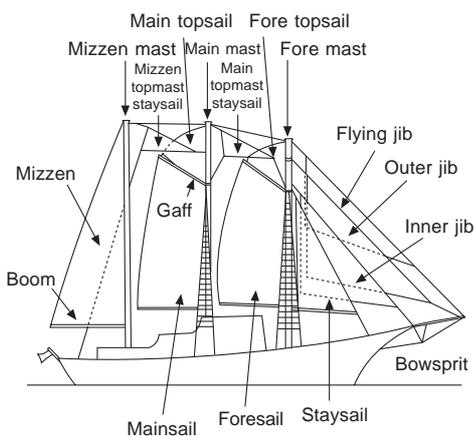


Figure 1.8 Sail disposition of British topsail schooner.

PLATE AND CONSTRUCTION TERMS

'A' Frame

Supporting framework for the stern tube of a twin-screw vessel. Used as an alternative to a spectacle frame.

Boss Plate

A shell plate parallel to the stern tube at the level of the propeller boss.

Bulkhead

A vertical partition between compartments. May be in the fore and aft line or athwartships.

Coffin Plate

The aftermost plate of the keel, dish (coffin)-shaped to fit the stern frame.

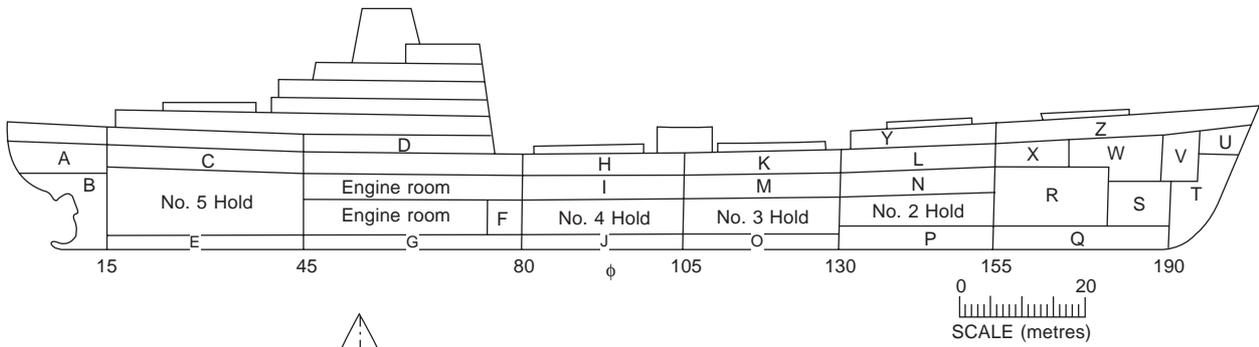
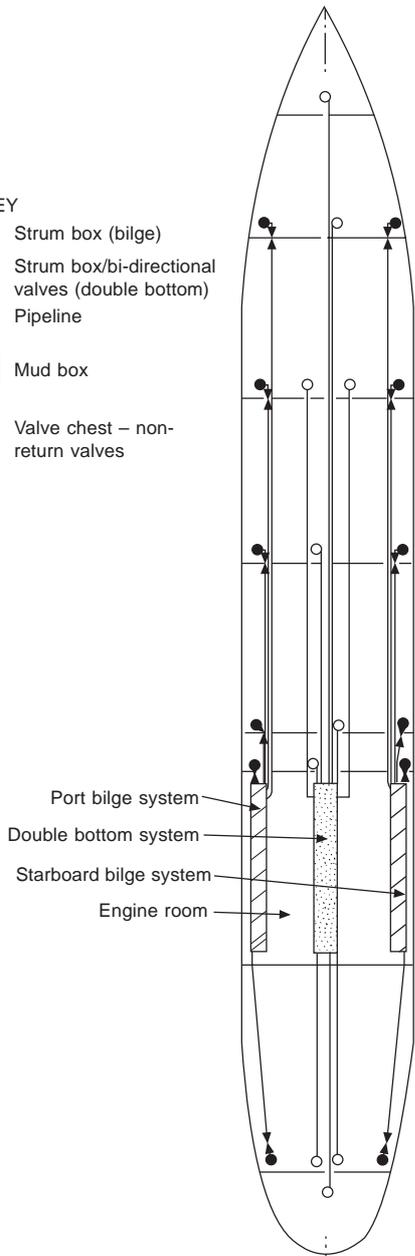


Figure 1.9 Longitudinal profile plan of general cargo vessel.

KEY

- Strum box (bilge)
- Strum box/bi-directional valves (double bottom)
- Pipeline
- ▨ Mud box
- ↓ Valve chest – non-return valves
- ↑



- A Steering gear flat
- B Aft peak
- C Upper 'tween deck
- D Poop 'tween deck
- E No. 5 double bottom tanks
- F Oil fuel tanks
- G Engine room double bottom tanks
- H Upper 'tween deck
- I Lower 'tween deck
- J No. 4 double bottom tanks
- K, L Upper 'tween deck
- M, N Lower 'tween deck
- O No. 3 double bottom tanks
- P No. 2 double bottom tanks
- Q No. 1 double bottom tanks
- R No. 2 cargo tank
- S Ballast tank
- T Forepeak
- U Store
- V Chain locker
- W No. 1 cargo tank
- X No. 1 upper 'tween deck
- Y No. 2 fo'c'sle 'tween deck
- Z No. 1 fo'c'sle 'tween deck

Figure 1.10 Typical hold bilge pumping system.

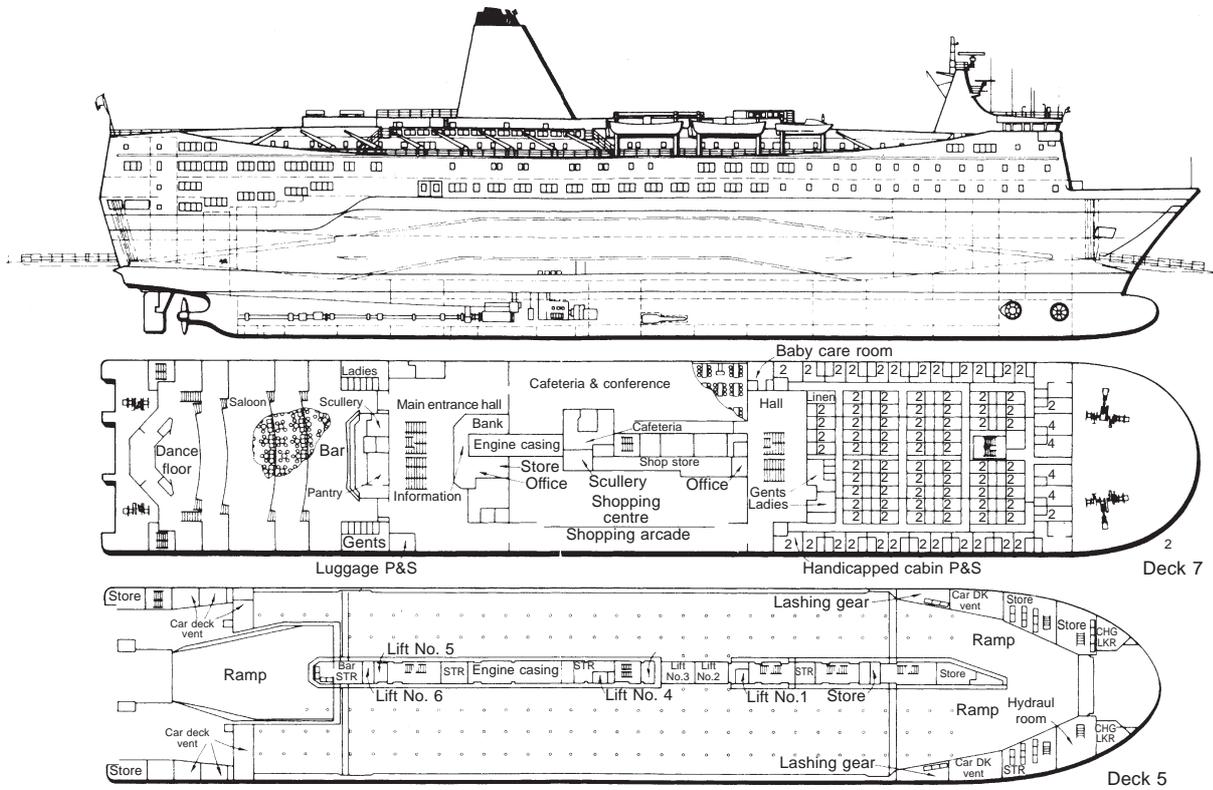


Figure 1.11 Profile and general arrangement plans of passenger/car ferry *Kronprinsessan Victoria* (15,000 gross tons).

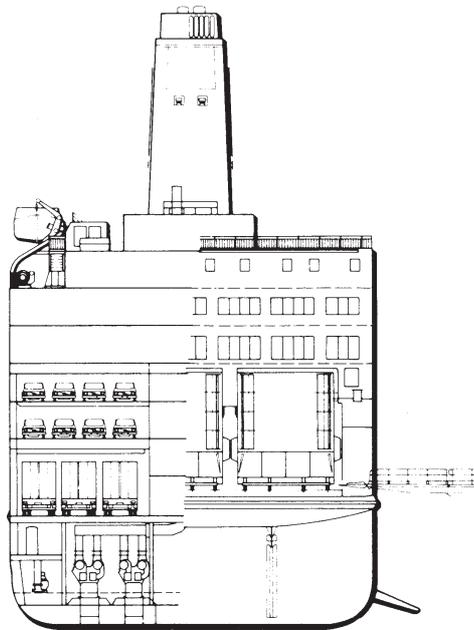


Figure 1.12 *Kronprinsessan Victoria* in section.

Length overall	150 m.
Moulded breadth	26 m.
Draught	6 m.
Deadweight (at design draught)	3100 tonnes.
Passenger complement	2100.
Trailer capacity	70 × 18 m.
Car capacity	700 × 4.5 m.

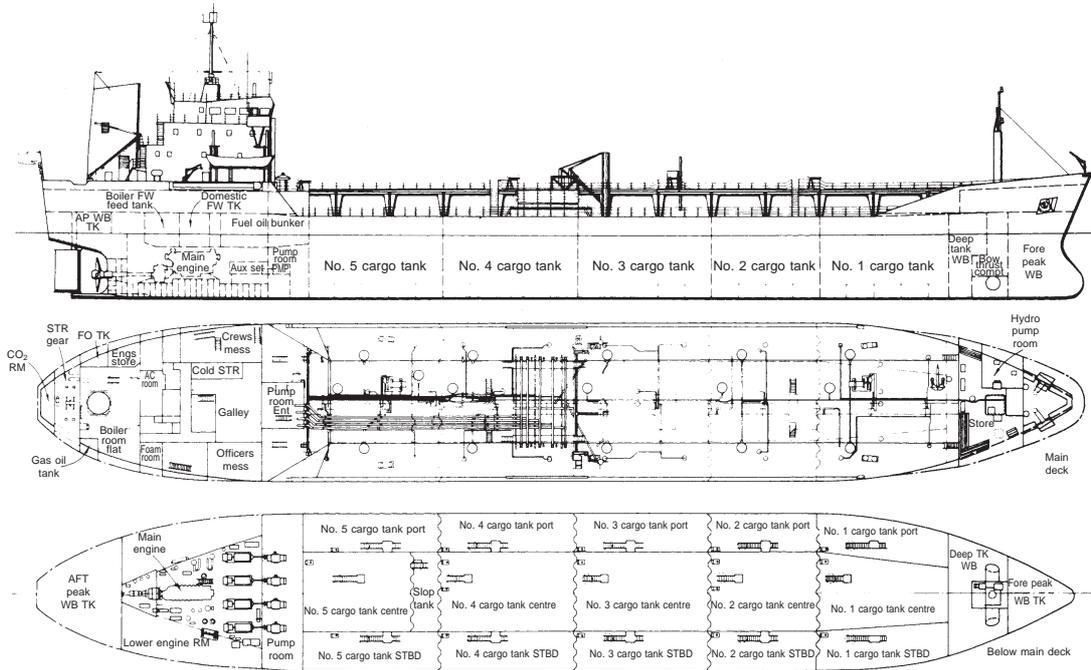


Figure 1.13 Profile and deck plans of 8030 tonne DW products tanker *Cableman*.

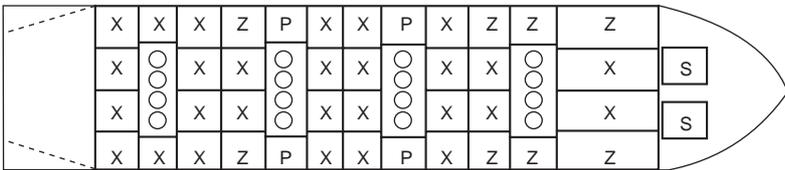
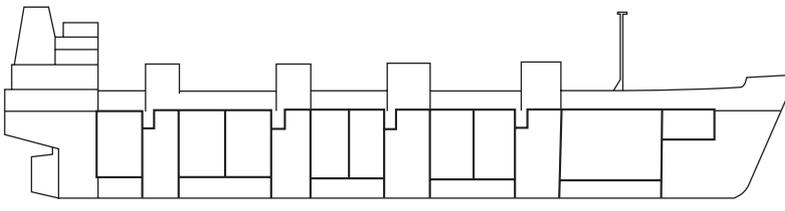
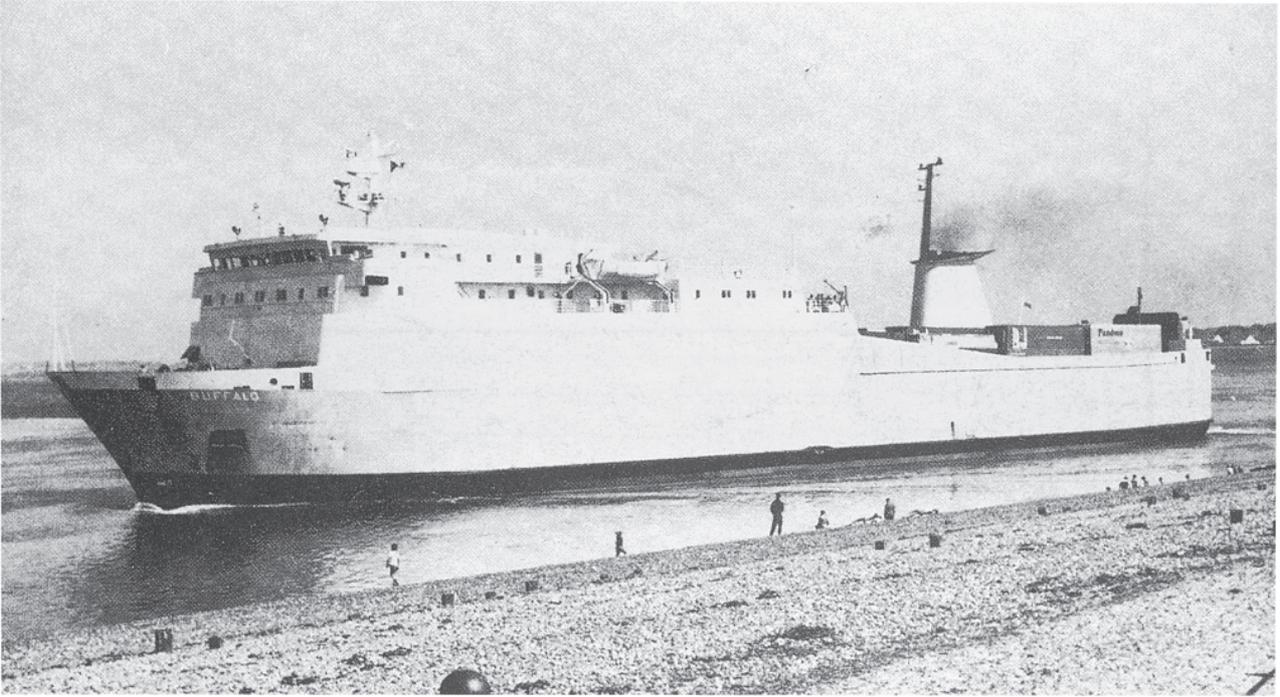
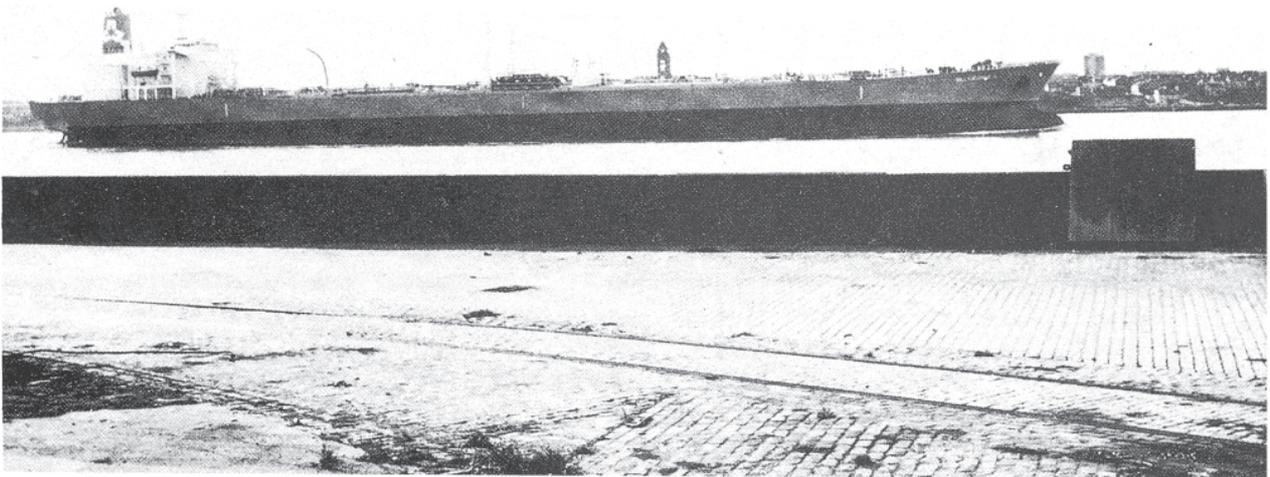


Figure 1.14 Product carrier (tanker). Six tanks have heating coils, and there are four main pump rooms, with a capacity of 200 tons of water per hour. For the stainless steel tanks, centrifugal pumps can supply 30 tons per hour.

Tank coatings
 P Polyurethane
 S Stainless steel
 X Epoxy coated
 Z Zinc silicate



1. The Roll On–Roll Off ferry. There is limited passenger/driver accommodation on three vehicle decks loaded from a stern door/ramp. An internal ramp runs to upper deck level and a hydraulic lift to lower hold. Trailer capacity is approximately one hundred 40-ft units.



2. The modern tanker, though small by today's supertanker size.
- NB. New tankers are now required to be built with double bottoms/double hulls to satisfy regulations.



3. Modern high speed passenger ferry engaged on the Irish sea trade.

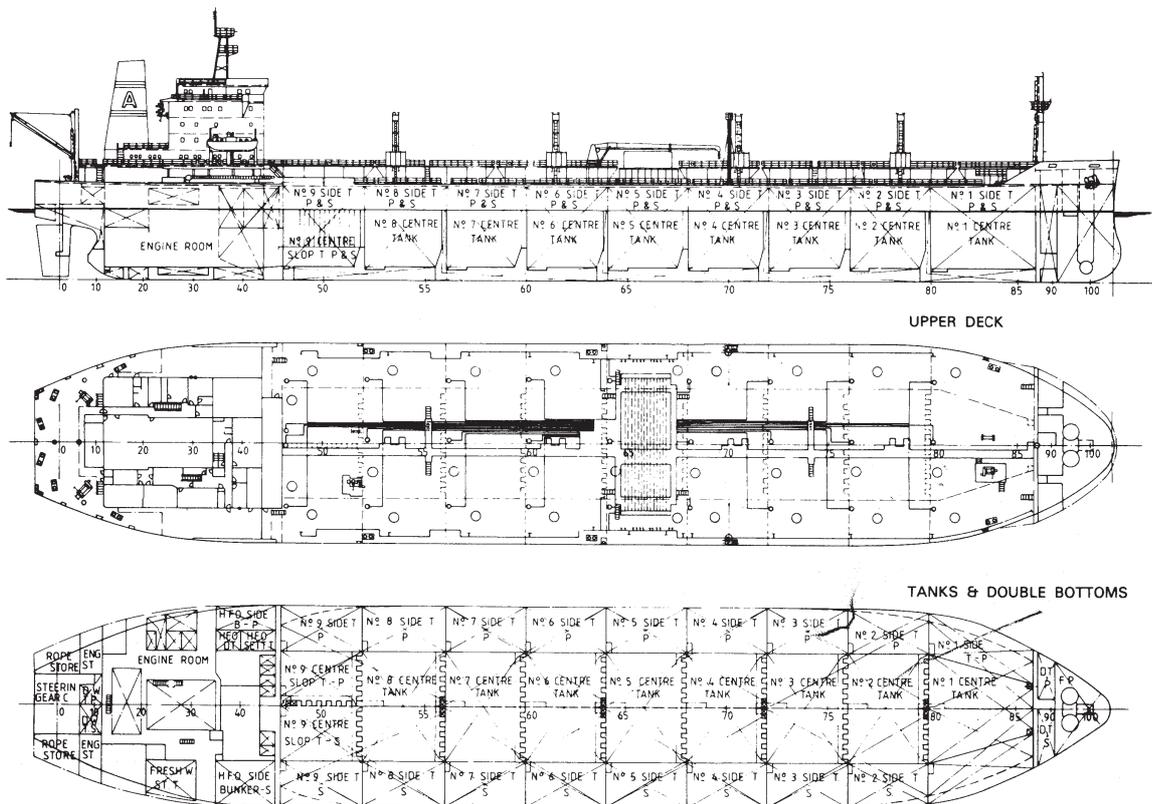


Figure 1.15 Chemical carrier.

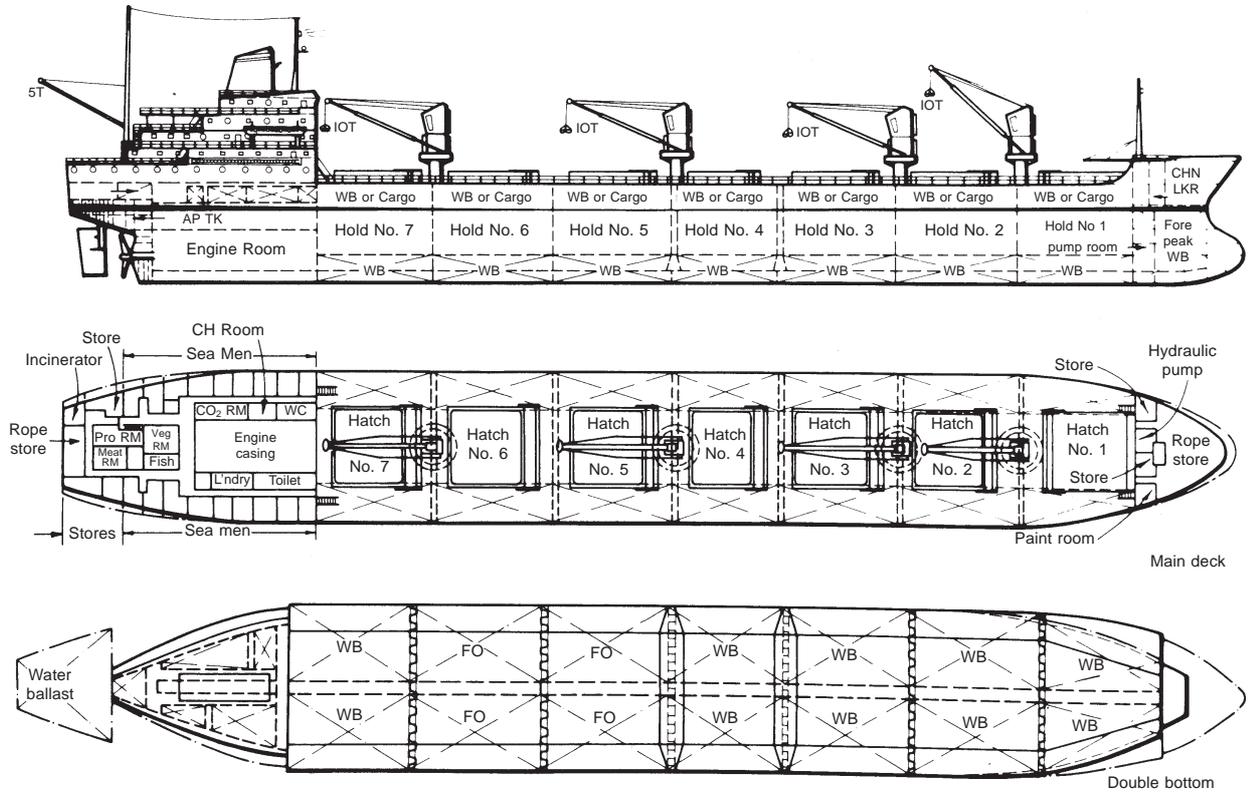


Figure 1.16 Lok Priti (bulk carrier).

Length, oa	172.02 m
Length, bp	162.40 m
Breadth, moulded	22.80 m
Depth, moulded	14.70 m
Draught, moulded	10.88 m
Gross register	15 638 grt
Net register	10 502 nrt
Deadweight, total at 10.67 m draught	26 000 dwt
Deadweight, total at 10.88 m draught	27 000 dwt
Capacities:	
Holds, including wing tanks and hatches	35 091 m ³
Ballast, including No. 4 hold	11 330 m ³
Heavy fuel	1530 m ³
Diesel fuel	94 m ³
Lube oil	135 m ³
Fresh water	208 m ³
Main engine	GRSE-MAN-B&W K6Z78.155E
Output, mcr ... (7833 kW) 10 500 bhp at 122 rev/min	
Trial speed, 87.5% mcr	
(9 188 bhp) at loaded draught	15.00 knots
Endurance	12 000 nautical miles
COMPLEMENT	
14 officers	2 cadets
8 petty officers	1 pilot
36 crewmen	1 owner
Total = 62	

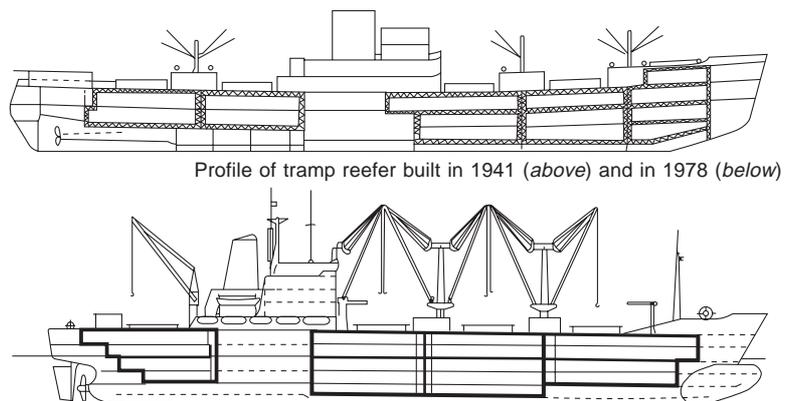


Figure 1.17 Refrigerated cargo lines (reefer) – early design (top) and modern design (below).

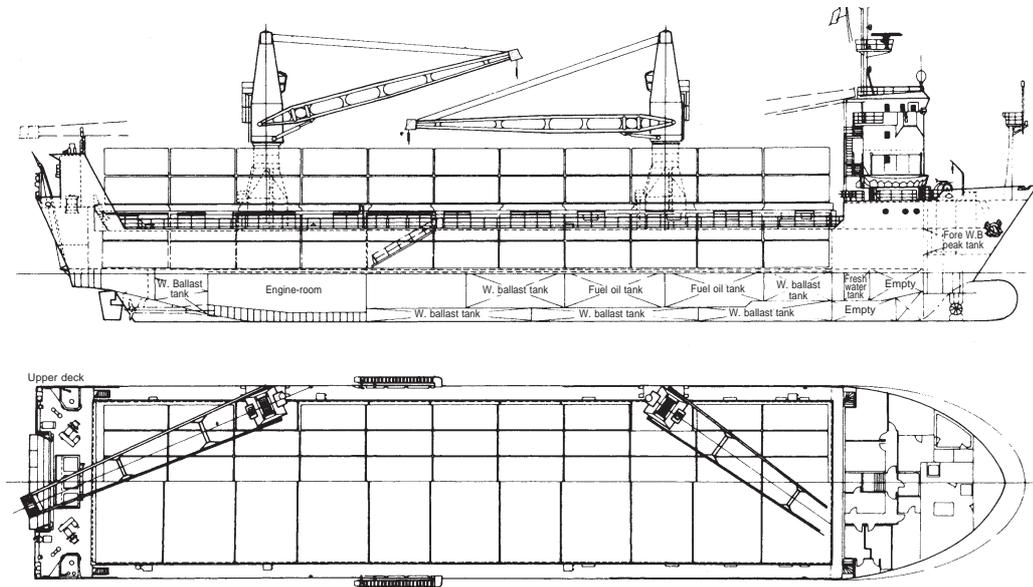


Figure 1.18 Profile and upper deck plan of CCN-Mau's 3450 DWT container RoRo/LoLo ship design.

Length oa	94.04 m	Complement	22
Length bp	80.00 m	Vehicle stern ramp.	
Breadth moulded	18.00 m	2 fixed deck cranes, 25 tonnes.	
Summer draught	4.55 m		

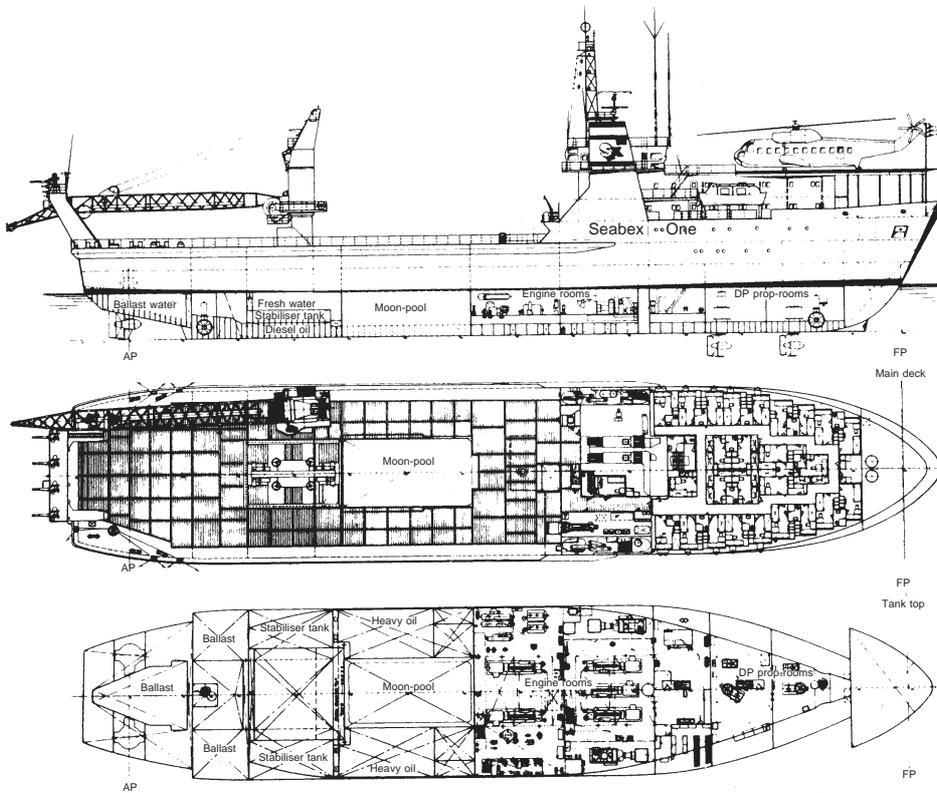


Figure 1.19 Seabex One – profile, maindeck and tank top plans of offshore support vessel

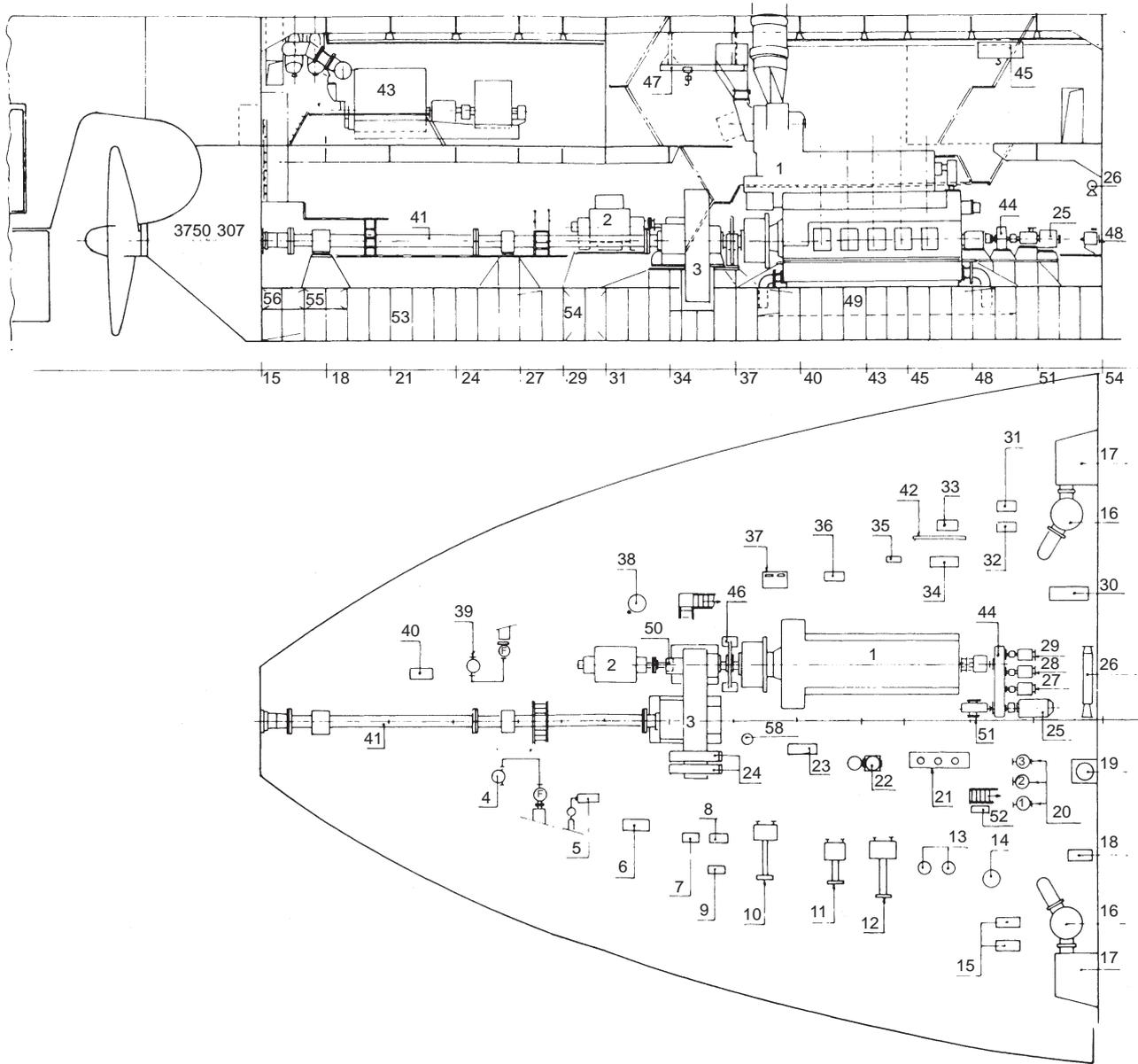
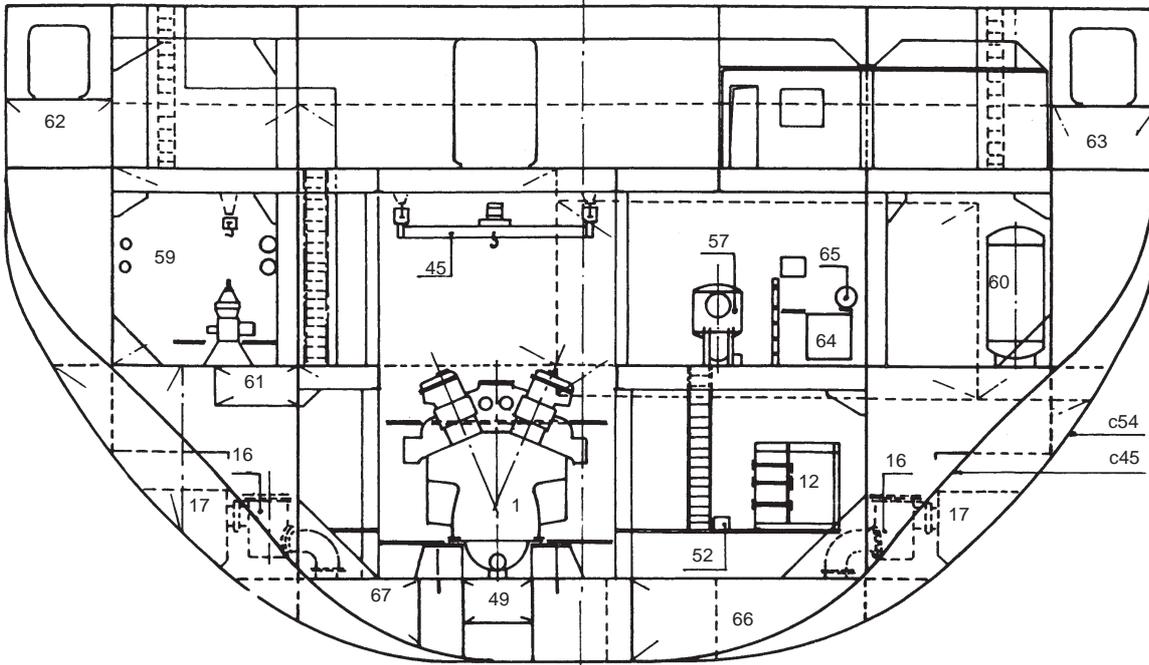


Figure 1.20 Engine-room layout and disposition of equipment on 13,230 DW container ship *Nathalie Delmas*.

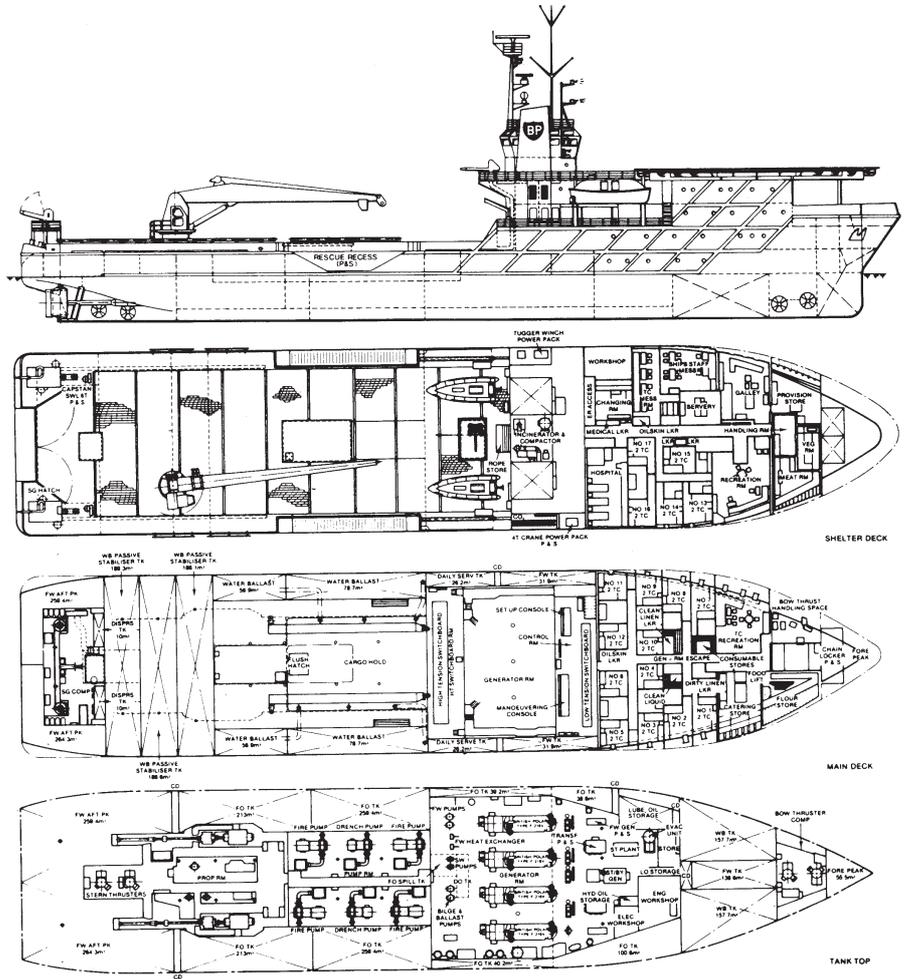


Key

- | | |
|---|---|
| 1 Main engine: SEMT-Pielstick 10PC4V-570 | 35 Accommodation fresh water pump |
| 2 Main engine driven alternator: Alsthom 950 kW | 36 Oil separator pump |
| 3 Reduction gear/thrust bearing: ACB 386/77 rev/min | 37 Lube oil tank and pumps for rocker arms |
| 4 Seawater pump for No. 1 diesel alternator | 38 Oily water separator |
| 5 Seawater pump (refrigerated provisions) | 39 Seawater pump for No. 2 diesel alternator |
| 6 Main engine local control | 40 Bilge automatic pump |
| 7 Oil transfer pump | 41 Shaft line |
| 8 Main engine freshwater heating pump | 42 Level indicator panel |
| 9 Swimming pool pump | 43 Diesel alternators: 2 × SEMT-Pielstick 6P A6L-280 engines driving Unilec 1350 kW alternators |
| 10 Main engine oil cooler | 44 Step up gear for main engine pumps: Citroen-Messian |
| 11 Freshwater/high temperature/main engine cooler | 45 Travelling crane |
| 12 Freshwater/low temperature/main engine cooler | 46 Brake: Twiflex |
| 13 Bilge and ballast pumps | 47 Rails for dismantling rotors of turbocharger |
| 14 Ballast pump | 48 'Cocooned' spare pumps |
| 15 Boiler feed pumps | 49 Main engine oil return to ballast tank |
| 16 Seawater filter | 50 Reduction gear oil pump |
| 17 Starboard water intake | 51 Main engine oil pump |
| 18 Evaporator ejector pump | 52 Fuel oil leakage protection pump |
| 19 Tunnel access | 53 Bilge water ballast tanks |
| 20 Seawater general service pump | 54 Diesel alternators' polluted oil ballast tank |
| 21 Main engine oil filters | 55 Sterntube oil drainage |
| 22 Main engine oil emergency pump | 56 Aft well |
| 23 Main engine pre-lube pump | 57 Evaporator |
| 24 Reduction gear oil coolers | 58 Reduction gear oil emergency pump |
| 25 Step up gear for electric motor | 59 Fuel oil/diesel oil treatment room: Alfa-Laval separators |
| 26 Heel pump | 60 Control air tank |
| 27 Main engine seawater pump | 61 Slop tanks |
| 28 Main engine/high temperature/freshwater pump | 62 Port side fuel oil reserve bunker for diesel alternators |
| 29 Main engine/low temperature/freshwater pump | 63 Starboard diesel oil reserve bunker |
| 30 Main fire pump | 64 Feed pressure tank |
| 31 Sludge transfer pump | 65 Drain cooler |
| 32 Fuel oil automatic pump | 66 Main engine oil reserve tank |
| 33 Diesel oil/fuel oil transfer pump | 67 Fuel oil/diesel oil overflow tank |
| 34 Fuel oil transfer pump | |

Figure 1.21 Safety/supply craft for the offshore industry.

- Length 94.3 m
- Moulded breadth 19.5 m
- Loaded draught 4.65 m
- Corresponding deadweight 2997 tonnes
- Gross registered tonnage 2826
- Net registered tonnage 945
- Fire fighting capability.
- Pollution control facility.
- Oil recovery equipment.
- Operates submersibles.
- Helicopter landing deck.
- Hospital facility.
- Command ship capability in emergency.



Collision Bulkhead

A heavy duty bulkhead in the forepart of the vessel to withstand damage after impact from collision.

Floor

A vertical athwartships member in way of the double bottom. A floor will run from the centre girder out to the margin plate on either side of the vessel. Floors may be in steel plate, solid or framed bracket form.

Frame

Internal support member for the shell plating (Figure 1.22). Vessels may be framed transversely or longitudinally.

Garboard Strake

The first strake out from the keel.

Gusset Plate

Triangular plate often used for joining angle bar to a plate.

Intercostal

A side girder in the fore and aft line sited either side of the keel. Integral connection with the tank top and the ship's bottom plating and rigidly connected by the floors.

Joggled Plating

A type of shell plating with an 'in/out' design at its edges (Figure 1.22). Effectively removes the need for liners, which would be required for the fitting of raised and sunken strakes.

Keel

Centre line plate passing from the stem to the stern frame. Referred to as a flat plate keel. Generally of increased scantlings.

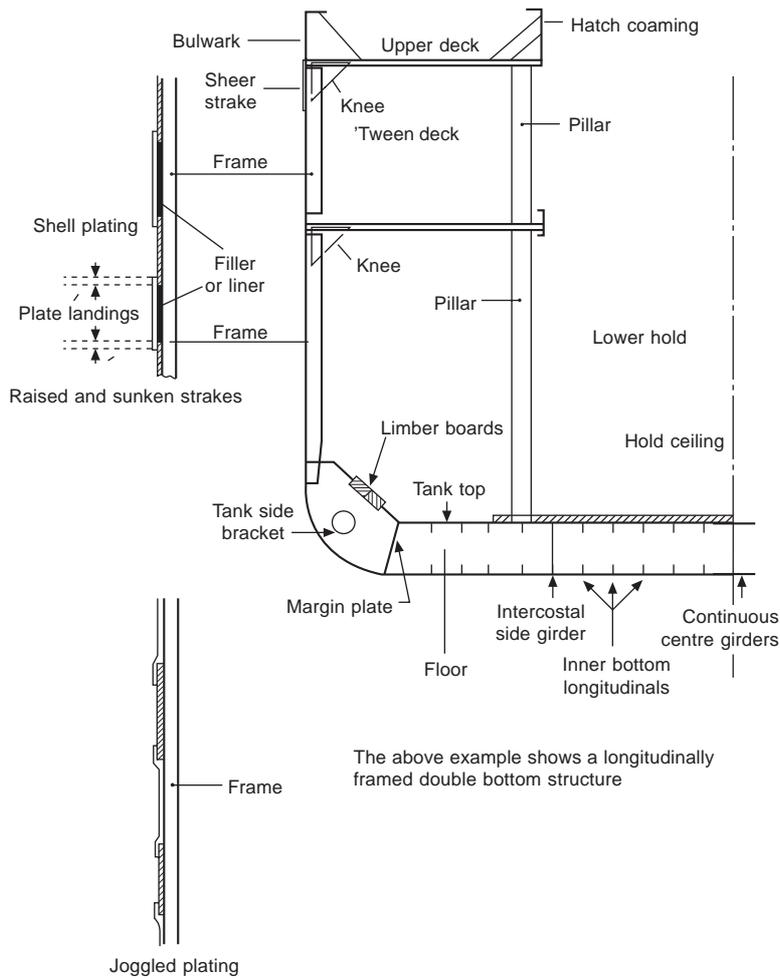


Figure 1.22 Midships section through general cargo vessel.

Duct Keel

The *duct keel* is a plated box/tunnelled keel allowing passage right forward. It provides additional buoyancy, together with a through passageway for cables and pipelines running in the fore and aft direction.

Lightening Holes

Holes cut into floors, or intercostals to reduce the weight content of the ship's build and to provide access to tank areas.

Longitudinal

A fore and aft strength member connecting the athwartships floors. Some vessels are longitudinally strengthened by having the frames run in a fore and aft direction as opposed to transverse framing. Additional longitudinals are to be found in areas where pounding can be anticipated when the vessel is at sea.

Margin Plate

A fore and aft plate sited at the turn of the bilge (Figure 1.22). The upper edge is normally flanged to allow connection to the tank top plating, while the opposite end is secured to the inside of the shell plate by an angle-bar connection. It provides an end seal to the double bottom tanks, having all the floors joining at right-angles, up to the collision bulkheads.

Oxter Plate

A shell plate of double curvature found under the transom floor, being extended from the fore side of the sternpost in the direction of the bow.

Panting Beams

Athwartships members in the forepart introduced to reduce the in/out tendency of the shell plating, caused by varying water pressure on the bow when the vessel is pitching.

Panting Stringers

Internal horizontal plates secured to the shell plating and braced athwartships by the panting beams.

Plate Landings

Refers to the shell plate. When shell plate is set in the raised and sunken method, the region where adjoining plates overlap is known as the plate landing (Figure 1.22).

Scantlings

Originally applied to the size of lintels in the building of wooden ships but now used to indicate the thickness of plates, angles and flanges. Measurements of steel sections.

Sheer Strake

The continuous row of shell plates on a level with the uppermost continuous deck (Figure 1.22).

Stealer Plate

A plate found at the extremities of the vessel in the shell or deck plating. Its purpose is to reduce the width of the plating by merging, say, three strakes into two. The single plate producing this effect is known as a stealer plate.

MAIN STRUCTURAL MEMBERS — COMPENSATING STRESS FACTORS
AFFECTING VESSEL

Beam Knees

Resist racking, heavy weights and localised stresses.

Beams

Resist racking, water pressure, and local stresses due to weights.

Bulkheads

Resist racking stresses, water pressure, drydocking, heavy weights, hogging and sagging, and shear forces.

Decks

Resist hogging and sagging, shearing, bending, heavy weights, and water pressure.

Floors

Resist water pressure, drydocking stresses, heavy weights, local stresses, racking, vibration and pounding.

Frames

Resist water pressure, panting, drydocking and racking stresses. May be compared to the ribs of the body, which stiffen the body of the vessel. May be longitudinally or transversely constructed.

Longitudinal Girders

Resist hogging and sagging, water pressure, drydocking and pounding stresses, and localised shearing stresses. Examples: keel, keelsons, fore and aft members, intercostals.

Pillars

Resist stresses caused by heavy weights, racking, drydocking and water pressure. Extensively found in general cargo vessels in lower hold structure.

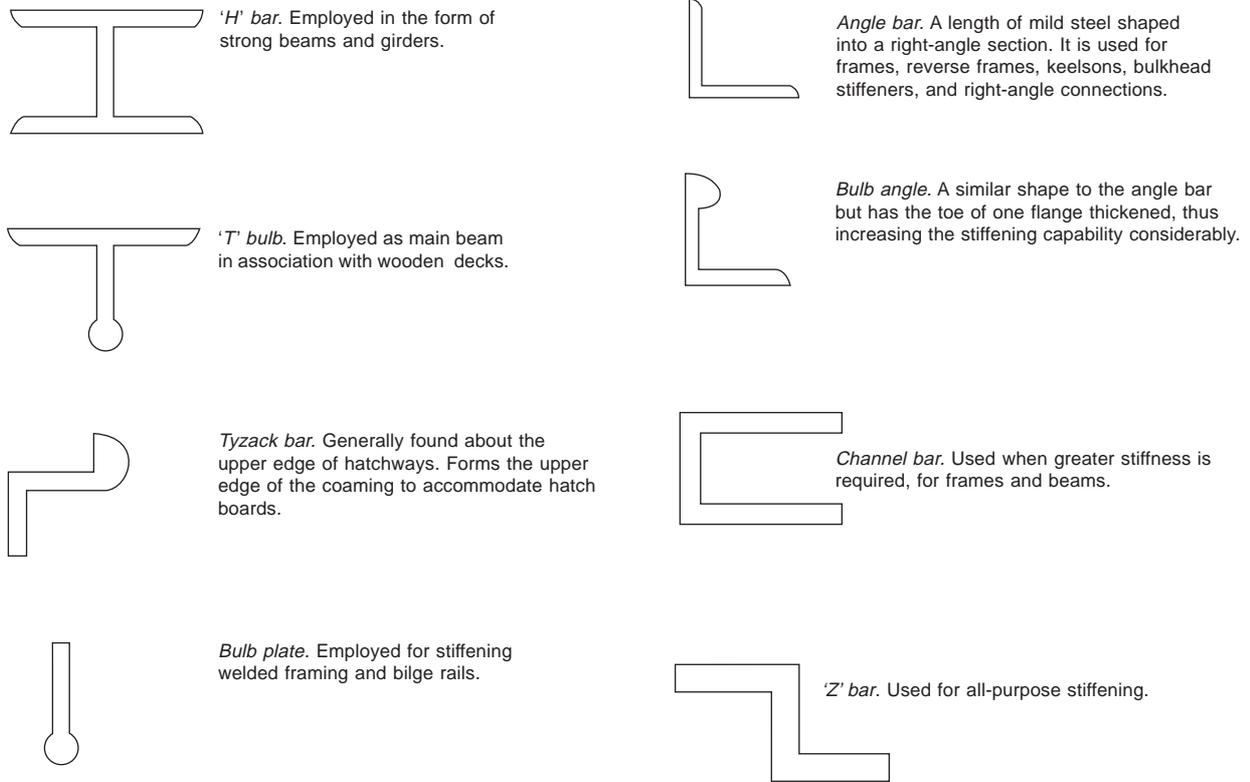


Figure 1.23 General steelwork sections used in basic ship construction.

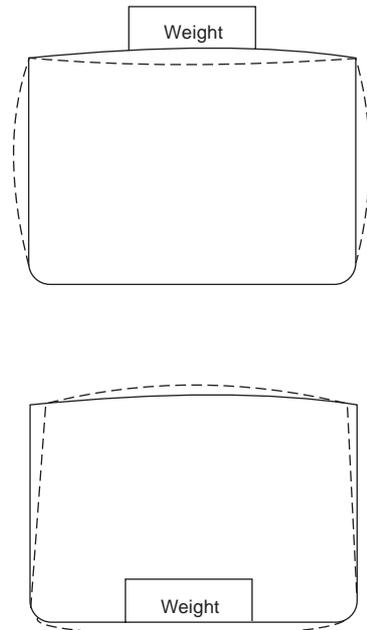


Figure 1.24 Pressure distortion due to heavy weights.

Shell Plating

Steel plates of various size, which, when joined together form the sides of the ship's hull. Plates are generally of an increased thickness (increased scantlings) in and about the keel area. The 'Garboard strake' and the 'Sheer strake' are also increased in thickness compared to other shell plates. Shell plating compensates for all stresses affecting the vessel. Where localised stresses are experienced as with 'shell doors' then increased scantlings can be expected to provide the continuity of strength required.

STRESSES IN SHIP STRUCTURES

It is the shipowner's responsibility to ensure that his vessel is built to a standard high enough to withstand all the stresses she may be expected to encounter. By their very nature ships are called upon to carry heavy loads, and considerable thought and experience is required to load heavy weights without causing structural damage to the vessel.

Heavy weights tend to cause a downward deflection of the deck area supporting the load (see Figure 1.24). This subsequently produces stresses, with consequent inward and outward deflections of supporting bulkheads, depending on the position of initial loading. These stresses are generally of a localised nature, in the neighbourhood of built-in structures such as

windlasses, accommodation blocks etc. and increased scantlings are the norm to prevent excessive distortion. The shipping of heavy seas may add to the load and aggravate the situation, causing unacceptable, excessive distortions.

Another form of stress comes from the water surrounding the ship, which exerts considerable pressure over the bottom and side areas of the shell plating (Figure 1.25). The pressure will increase with depth of immersion, i.e. the pressure on the bottom shell plates will exceed that on the side shell plates.

Water pressure does not maintain a constant value, and will vary when the vessel is in a seaway, especially when a heavy swell is present. Fluctuations in water pressure tend to cause an ‘in and out’ movement of the shell plating, with more noticeable effects at the extreme ends of the vessel. The effect of water pressure is usually more prominent at the fore end of the vessel than the after end. The general effect is accentuated by the pitching motion of the vessel and is termed ‘panting’.

We have already defined panting beams, which are substantial metal beams running from port to starboard, in the forepart of the vessel. They are positioned forward of the collision bulkhead to resist the in and out motion of the shell plating either side of the fore and aft line. Situated at various deck levels, panting beams form a combination with panting stringers on either side in the forepart of the vessel.

A third form of stress is shearing stress in a material, which tends to move one part of the material relative to another. Consider the vessel in Figure 1.27, assumed to have loaded cargo in its centre hold, ballast water in the forepart, and accommodation and machinery space all aft. Shearing forces will be experienced at points A, B, C and D. If we assumed that the various sections were free to move, then, owing to the weight distribution throughout the vessel’s length, sections X, Y, and Z (Figure 1.28) would have a tendency to move downwards (by the law of gravity), while sections P and Q would have a tendency to move upwards, due to the forces of buoyancy.

The two forces of gravity and buoyancy acting in opposition in this way explain the shearing stress experienced at points A, B, C and D. Shearing forces are undesirable within a ship in any shape or form, and prudent loading, together with careful ballast distribution, can reduce them.

Values of stresses incurred during the loading period may be mathematically worked out and then plotted to show the areas of stress by graph. It is worth noting that the mathematical calculations are lengthy, and always leave the possibility for error. ‘Stress finders’ have reduced the risk of errors. There are several on the market, generally custom made for individual vessels, and they provide the operator with such items of information as:

1. Bending moment.
2. Shear stress at critical points.
3. Mean draught.
4. Trim of the vessel.

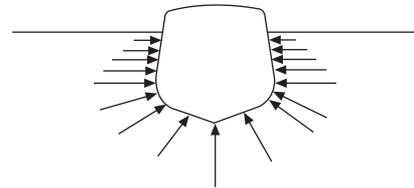


Figure 1.25 Pressure of water on ship’s hull.

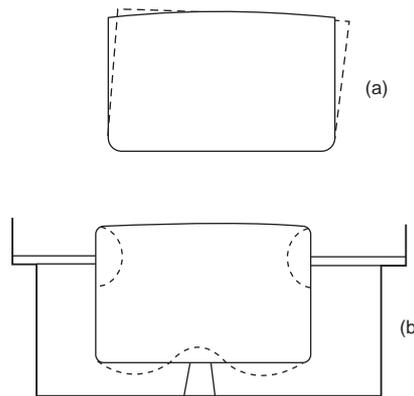


Figure 1.26 (a) Racking is distortion in ship’s structure due to rolling action in a seaway. (b) Drydocking stresses are caused by pressure from drydock shores and keel blocks in local areas of the shell plating and associated strength members.

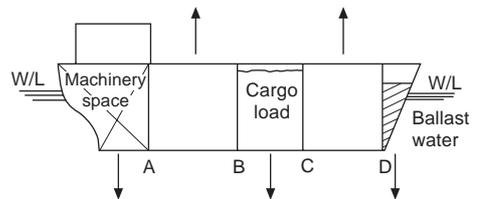


Figure 1.27 Shearing stresses.

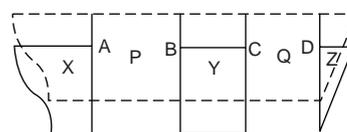


Figure 1.28

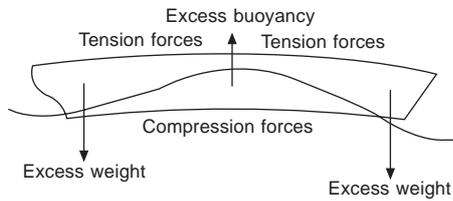


Figure 1.29 Hogging.

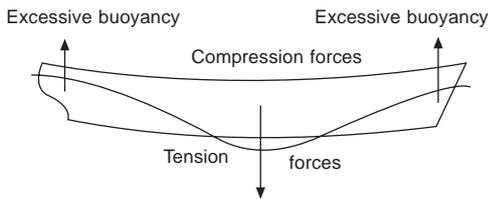


Figure 1.30 Sagging.

5. GM final, after loading.
6. Deadweight.

The information supplied depends on the make and type of machine.

Hogging

The length of the vessel may be considered to act like a long girder pivoted on a wave about its centre. In this position the fore and after ends of the vessel will bend downwards, causing compression forces in the keel area and tension forces at the upper deck level (Figure 1.29).

The condition is brought about by increased buoyancy forces being created at and around the midships point of the vessel. Increased gravitational force, due to the metal structure of the vessel acting vertically downward, occurs at the extremities of the ship. When both forces exist at the same time, e.g. as the vessel is pivoted by a wave midships, a ‘hogging’ condition is present.

This can be accentuated in a vessel of an all-aft design, where the additional weight of the machinery space would produce high loading in the aft part of the vessel. The condition may also be unnecessarily increased by ‘bad’ cargo loading in the fore and after parts of the vessel, leaving the midships area comparatively lightly loaded.

Sagging

‘Sagging’ is the direct opposite of hogging. When a vessel is supported at bow and stern by wave crests, she will tend to sag in the middle. High buoyancy forces occur at the extremities of the ship. High gravitational forces, from the weight of the ship’s structure, act vertically down about the midship’s point, in opposition to the buoyancy forces. In comparison with the condition of hogging, the vessel has a tendency to bend in the opposite direction (Figure 1.30).

Incorrect loading of the vessel or design characteristics may accentuate the condition of sagging. Watchkeeping officers should be aware of the frequency of the waves and the likelihood of this condition developing and, if necessary, take action to relieve any sagging or hogging conditions by altering the ship’s course.

Due consideration at the time of loading, with regard to weight distribution may alleviate either hogging or sagging. With shipbuilding producing larger and longer ships either condition is most undesirable, as the prospect of breaking the ship’s back in a heavy seaway or swell becomes a frightening reality. Prudent ballast arrangements, together with increased scantlings at the time of building, coupled with efficient ship and cargo loading, will help minimise any structural damage at a later stage due to hogging or sagging.

LOADLINES

Loadlines are marks punched into and painted on the sides of British merchant vessels (Figure 1.31). These Plimsoll marks take their name from the politician Samuel Plimsoll (1824–98), who persevered for many

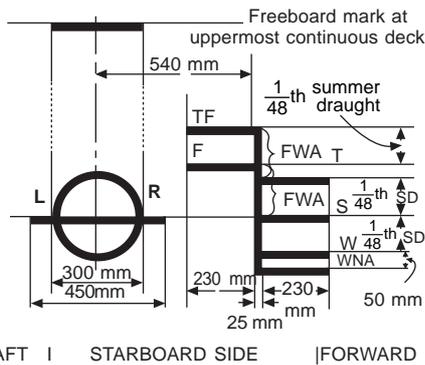


Figure 1.31 Loadlines.

- LR Lloyds Register, Classification Society.
- TF Tropical Fresh
- F Fresh
- T Tropical
- S Summer Loadline Draught
- W Winter
- WNA Winter North Atlantic

years before seeing a bill through Parliament, in 1876, which resulted in the Merchant Shipping Act. The Act gave the Department of Trade and Industry, as we now know it, the right of inspection, to ensure that a vessel should not be overloaded beyond her Plimsoll mark or line.

Samuel Plimsoll championed the improvement of conditions for the seafarer, and became the President of the Sailors and Firemens Union in his later years.

Assigning a Vessel's Loadline

The assigning of a vessel's loadline by the Department of Trade or other similarly approved assigning authority is carried out in accordance with the Loadline Rules, which were set and devised by the International Conference on Loadlines.

The calculation regarding the freeboard and consequently the position of loadlines will be dependent on the type of vessel and its length, ships being divided into two types, 'A' and 'B'.

Type 'A' – Vessels designed to carry only liquid, bulk cargoes, e.g. tankers.

Type 'B' – All other vessels not governed by the Type 'A' definition.

The assigning of the freeboard will be governed by many factors and it is not within the scope of this text to detail the loadline rules. (Additional information is obtainable from Murray-Smith, 'The 1966 International Conference on Loadlines', Trans. R.I.N.A., 1969.)

With the exception of pleasure yachts, warships and the like, all British ships and the majority of vessels of other maritime nations over 80 net registered tons are obliged to be marked with statutory loadlines, to ensure that they are not overloaded. Various authorities assign loadlines on behalf of the British Government, e.g. Det Norske Veritas (DNV), Lloyds Register (LR), Department of Trade (DT).

A loadline certificate must be displayed in a prominent place aboard the vessel. The certificate is valid for five years, but an annual survey is

'Computer Software'

Many vessels now employ computer loading programmes to establish disposition of cargo, ballast and stores.

Such software can be beneficial in producing the ships stability data, together with anticipated stress factors throughout the ships length.

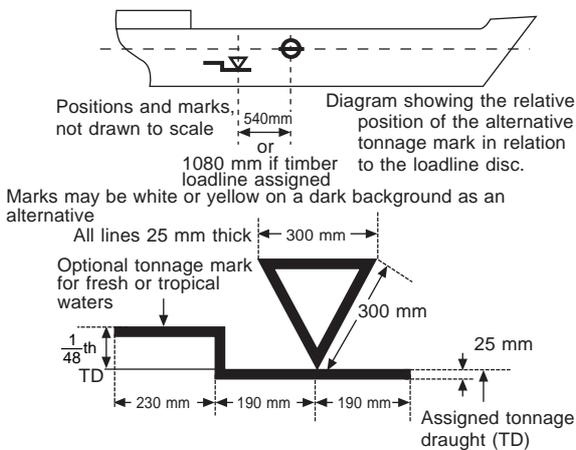


Figure 1.32 Alternative tonnage marks.

ANCHOR WORK



With the many different types of vessel employed in the marine industry, it is only to be expected that anchors and their associated equipment have changed considerably over the years. From the forerunners used by the ancient Greeks to the present day, purpose and design have been dictated by the needs of the industry.

ANCHORS

Admiralty Pattern Anchor

Sometimes referred to as a ‘fisherman’s’ anchor, this design is still popular within the fishing industry (Figure 2.1(a)). It has been in use for many years, but because it has difficult stowage characteristics, e.g. it cannot be stowed flat with the stock in position, it has been followed by more manageable designs. Once let go, the stock, lying at right-angles to the direction of the arms/flukes, causes a fluke to dig into the sea bed. This leaves the remaining fluke exposed, and the cable may often foul it when the vessel swings. When the anchor is not in use, the forelock in the stock can be unshipped, permitting the stock to be stowed parallel to the shank.

The holding power of this anchor is generally considered to be very good indeed. The design is such that the stock is longer and heavier than the arms. This lends itself to the theory that the stock will be dragged flat along the sea bed, causing one of the flukes to bury itself. The angle of the stock would also be expected to turn the flukes in the direction of the sea bed as the anchor strikes the bottom. It is interesting to note that the longer the shank on these anchors the better it holds.

The weight of the stock must be equal to 25 per cent of the weight of the anchor itself. Some stocks are designed straight if the weight of the anchor is over 12 cwt (610 kg), but a bent stock, as indicated in Figure 2.1(a) would be encountered on anchors below this weight.

The holding power of this common anchor will be, roughly speaking, three to four times its weight, depending on the nature of the sea

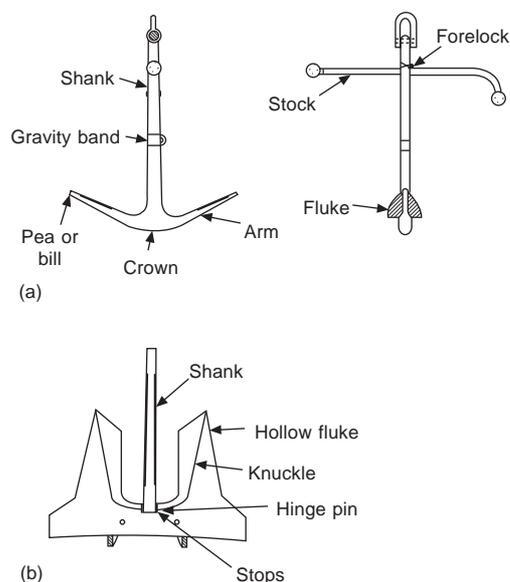


Figure 2.1 Admiralty pattern anchor (*above*) and (*below*) Admiralty cast anchor type 14 (AC14).

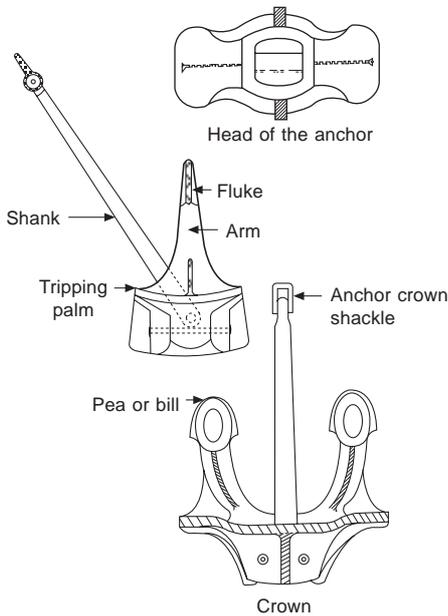


Figure 2.2 Hall stockless anchor.

bottom. It is unlikely to be seen on board merchant vessels, except possibly as a lifeboat anchor or as a kedge anchor. The weight in any event would rarely exceed two tonnes.

The Stockless Anchor

This is by far the most popular anchor in general use today its principal parts are shown in Figure 2.2. The head of the anchor is secured to the shank by a hinged bolt which allows the arms to form an angle of up to 45° with the shank. Further rotation of the arms are prevented by the head meeting the shank, at the built-in stops. The head of the anchor is comprised of the flukes, the arms, and the crown which are manufactured from cast steel, whereas the shank is made of cast steel or forged iron. The hinge bolt and the shackle are made of forged iron. The stockless anchor's greatest advantage is its close stowing properties and is easily housed in the hawse pipe when not in use. It is easily handled for all anchor operations, and made anchor beds (used with the close stowing anchor) obsolete.

The overall size of these anchors will vary between individual ship's needs but the head must be at least three-fifths of the total weight of the anchor. Holding power again varies depending on the nature of the bottom but, as a rule of thumb, it may be considered to be up to three times its own weight. The mariner should be aware that the rotation action of the moving arm may cause the anchor to become choked when on the sea bed so that the arms/flukes are not angled to the full amount and therefore losing the holding power effect.

Admiralty Cast Anchor

Used extensively as a bower anchor for warships, this anchor, because of good holding properties, is becoming very popular with the merchant service (Figure 2.1(b)). With the increase in size of ships – the large tankers of today, for example – shipowners required an anchor with greater holding power. The AC Type 14, as it was called, was developed in the United Kingdom and has the required properties. Tests showed that it had more than twice the holding power of a conventional stockless anchor of the same weight. With such an obvious advantage, Lloyds Classification Society granted a 25 per cent reduction in regulation weight. The holding properties of this anchor are directly related to the fluke area, the angle of which operates up to 35° to the shank. The angle of the flukes is made possible by a similar operation as with the stockless anchor, in which a hinge pin passes through the shank in the crown of the anchor.

CQR

Illustrated in Figure 2.3, the CQR sometimes referred to as a 'Plough-share' anchor or, in the United States, just as a plough anchor. It is generally used as a mooring anchor, especially for the smaller type of vessel. Holding power is again dependent on the type of ground that the

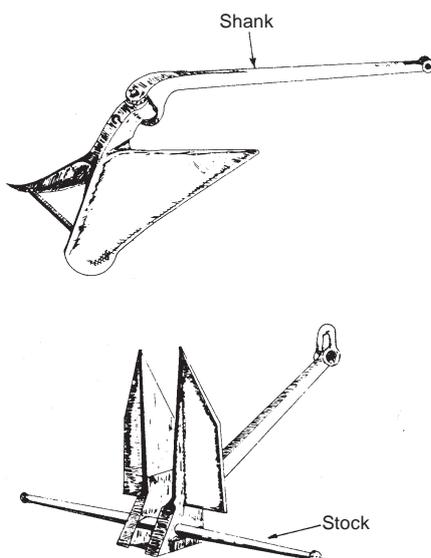


Figure 2.3 CQR anchor (above), Danforth anchor (below).

anchor is bedding into but has been found to be very good. It also has extremely good resistance to drag. Like the Admiralty Pattern, it is difficult to stow. The design has been modified since its invention to incorporate a stock, and is often used as a mooring anchor (Figure 2.28(b)). The CQR was a British invention by scientist Sir Geoffrey Taylor, who was a man with little boating experience. The invention showed that the application of basic principles can sometimes improve on practical experience. Small-boat owners tend to have the choice of two anchors on the market, namely the Danforth and the CQR. Both anchors have reasonable holding power but the Danforth may have a tendency to drag whereas the CQR will not.

For easier handling and stowing the Danforth would be more popular, but if it is decided to use an anchor for the job it was meant for, preference is generally given to the CQR.

Danforth Anchor

Generally accepted as a small-boat anchor, this anchor dominates the American boat market (Figure 2.3). A stock passes through the head of the anchor, allowing it to be stowed easily in a similar manner to the stockless anchor. Holding power is about 14.2 times its own weight. The anchor is of American design, and the idea of the stock being passed through the crown of the anchor as opposed to the top of the shank demonstrates a practical solution to the stowage problem. The stock in this position prevents the anchor being fouled on its own cable. Holding properties are good but not as good as the CQR's, and it has a tendency to drag or glide until the flukes bite into the sea bed. The action of this anchor is similar to that of the stockless anchor, where the tripping palms catch and cause the flukes to be angled to the shank. With the Danforth anchor, the tripping palms are generally situated closer to the centre line of the anchor. Once tripped, the spade-shaped flukes will tend to dig into the bottom.

TESTS ON ANCHORS

All anchors over 168 lb (76 kg) in weight must be tested and issued with a test certificate. The weight of any anchor for the purpose of the rules and regulations governing anchors and cables shall:

- (a) for stockless anchors include the weight of the anchor together with its shackle if any, and
- (b) for stocked anchors, the weight of the anchor including its shackle, if any, but excluding the stock.

Drop Test (cast anchors)

Any part of an anchor over 15 cwt is subjected to a percussion test by being dropped both end on and side on from a height of 12 ft on to an iron or steel slab. After that, the piece must be slung and hammered all over by a 7 lb sledgehammer. A clear ring must be produced to show that no flaw has developed during the percussion test.

TABLE 2.1 Proof loads for anchors

<i>Weight of anchor</i>	<i>Proof load</i>										
Kg	Tonne										
76	3.33	700	15.20	2300	39.60	4700	65.10	7200	82.60	15000	117.70
80	3.46	750	16.10	2400	40.90	4800	65.80	7400	83.80	15500	119.50
90	3.70	800	16.90	2500	42.20	4900	66.60	7600	85.00	16000	120.90
100	3.99	850	17.80	2600	43.50	5000	67.40	7800	86.10	16500	122.20
120	4.52	900	18.60	2700	44.70	5100	68.20	8000	87.00	17000	123.50
140	5.00	950	19.50	2800	45.90	5200	69.00	8200	88.10	17500	124.70
160	5.43	1000	20.30	2900	47.10	5300	69.80	8400	89.20	18000	125.90
180	5.85	1050	21.20	3000	48.30	5400	70.50	8600	90.30	18500	127.00
200	6.25	1100	22.00	3100	49.40	5500	71.30	8800	91.40	19000	128.00
225	6.71	1150	22.80	3200	50.50	5600	72.00	9000	92.40	19500	129.00
250	7.18	1200	23.60	3300	51.60	5700	72.70	9200	93.40	20000	130.00
275	7.64	1250	24.40	3400	52.70	5800	73.50	9400	94.40	21000	131.00
300	8.11	1300	25.20	3500	53.80	5900	74.20	9600	95.30	22000	132.00
325	8.58	1350	26.00	3600	54.80	6000	74.90	9800	96.20	23000	133.00
350	9.05	1400	26.70	3700	55.80	6100	75.50	10000	97.10	24000	134.00
375	9.52	1450	27.50	3800	56.80	6200	76.20	10500	99.30	25000	135.00
400	9.98	1500	28.30	3900	57.80	6300	76.90	11000	101.50	26000	136.00
425	10.50	1600	29.80	4000	58.80	6400	77.50	11500	103.60	27000	137.00
450	10.90	1700	31.30	4100	59.80	6500	78.20	12000	105.70	28000	138.00
475	11.40	1800	32.70	4200	60.70	6600	78.80	12500	107.80	29000	139.00
500	11.80	1900	34.20	4300	61.60	6700	79.40	13000	109.90	30000	140.00
550	12.70	2000	35.60	4400	62.50	6800	80.10	13500	111.90	31000	141.00
600	13.50	2100	36.90	4500	63.40	6900	80.70	14000	113.90		
650	14.30	2200	38.30	4600	64.30	7000	81.30	14500	115.90		

Proof loads for intermediate weights shall be obtained by linear interpolation.

The Bending Test (cast anchors)

An additional piece of metal, 20 cm long, is cast with the piece to be tested, and is cut away for the purpose of the bending test. This piece will be turned down to 2.5 cm in diameter, and bent cold by hammering through an angle of 90° over a radius of 3.75 cm. The casting will be deemed sufficiently ductile if no fracture appears in the metal.

All anchors are subject to the proof strain (Table 2.1), and subsequent proof load, but only cast steel anchors will be subjected to percussion, hammering, and bending tests. Wrought iron, or forged steel anchors are not subjected to these tests as they are forged from red hot slab by hammering. All other anchors will also be annealed.

MARKS ON ANCHORS

Each anchor must carry on the crown and on the shank the maker's name or initials, its progressive number, and its weight. The anchor will also bear the number of the certificate, together with letters indicating the certifying authority (Figure 2.4).

ANCHOR CERTIFICATE

After the test on the anchor is completed, an anchor certificate will be awarded. The certificate will show the following:

- Type of anchor.
- Weight (excluding stock) in kilogrammes.
- Weight of stock in kilogrammes.
- Length of shank in millimetres.
- Length of arm in millimetres.
- Diameter of trend in millimetres.
- Proof load applied in tonnes.
- Identification of proving house, official mark and government mark.
- Number of test certificate.
- Number of tensile test machine.
- Year of licence.
- Weight of the head of the anchor.
- Number and date of drop test.

CHAIN CABLE TESTS

Anchor cable over 12.5 mm in diameter is accepted for testing at an approved testing establishment in lengths of 27.5 m. (1 shackle of cable). The manufacturer will provide three additional links for the purpose of the test. These three links will be subjected to a tensile breaking stress, and if this proves to be satisfactory, then the total length of the cable will be subjected to a tensile proof test, the tests being carried out on approved testing machines. If two successive links break, the cable is rejected. Before the test on chain cable is carried out, the supervisor will satisfy

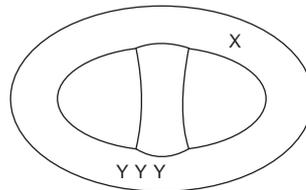


Figure 2.4 Marks on cable. X (certificate Number); YYY (certifying Authority).

himself that the quality of the material from which the cable is manufactured meets with the requirements of the anchor and chain cable regulations.

After a successful test on chain cable a certificate is awarded, stating:

- Type of cable.
- Grade of cable.
- Diameter in millimetres.
- Total length in metres.
- Total weight in kilogrammes.
- Length of link in millimetres.
- Breadth of link in millimetres.
- Tensile breaking load applied in tonnes.
- Tensile proof load applied in tonnes.
- Number and types of accessories included.

The certificate issued shall also show:

- A serial number.
- Name of the certifying authority.
- Mark of the certifying authority.
- Name of the testing establishment.
- Mark of the testing establishment, if any.
- Name of the supervisor of tests.

The certificate is signed on behalf of the certifying authority.

NOTES ON CABLE

Accessories

Anchor shackles, and joining shackles are all ordered together with any additional fittings for the size of cable they are intended to work and be associated with. These accessories must be subjected to similar tensile load and proof load tests as the cable.

Material of Manufacture

Wrought iron, forged mild steel, cast steel, or special quality forged steel are used. Wrought iron is weaker than the other three materials, and is expensive to produce; consequently it is rarely seen on present-day merchant ships. Types of cable are shown in Tables 2.2 and 2.3.

Size of Cable

The size is measured by the diameter of the bar from which the link is manufactured. Aboard a vessel the size could be obtained from the chain cable certificate, or callipers could be used to measure the actual cable.

KENTER LUGLESS JOINING SHACKLE

The Kenter Lugless Joining Shackle, manufactured in nickel steel, is the most popular method of joining shackle lengths of the anchor cable together. The shackle has four main parts, as shown in Figure 2.5. The

TABLE 2.2 Types of chain cable

Grade	Material	27.5 m = 15 fathoms = 1 shackle length		Tensile range kg/mm ²
		Method of manufacture		
1a	Wrought iron	Fire welded		31–41
1b	Mild steel	Fire welded		31–41
1c	Mild steel	Flash butt welded		31–41
1d	Mild steel	Flash butt welded		41–50
2a	Steel	Flash butt welded or drop forged		50–65
2b	Steel	Cast		50 min
3a	Steel	Flash butt welded or drop forged		70 min
3b	Steel	Cast		70 min

TABLE 2.3 Stud link chain cable

Diam. mm	I (U1)		II (U2)		III (U3)		Minimum weight per shackle length
	Proof	Break	Proof	Break	Proof	Break	
12.5	4.7	6.7	6.7	9.4	9.4	13.5	0.105
50.0	70	100	100	140	140	200	1.445
60.0	98.8	141	141	198	198	282	2.075
70	132	188	188	263	263	376	2.85
90	209	298	298	417	417	596	4.705
122	357	510	510	714	714	1019	8.55
152	515	736	736	1030	1030	1471	13.20

two main halves interlock with the stud forming the middle of the link. All parts are held together with a tapered spile pin. This spile pin is made of steel and is driven into the shackle on the diagonal. A lead pellet is then forced into the inverted dovetail recess to prevent the pin from accidentally falling from the shackle.

The manufacture of the shackle in nickel steel prevents corrosion and the parts becoming frozen together. It allows the shackle to be 'broken' with relative ease when either the cable is to be end-for-ended or shackles are to be tested. When breaking the shackle, remove the spile pin by using a punch and drift (Figure 2.15). If the lead pellet has not been prised out first, be careful that it is not forced out by the percussion effect of the drift driving the spile pin, for it may emerge with considerable force. A back stop should be provided to prevent persons being injured by the lead pellet being expelled from the recess.

Once the spile pin is removed, the stud can be extracted; the two halves of the shackle can then be separated by means of a top swage obtained from the manufacturer. When the shackle is reassembled, care must be taken to ream out the dovetail recess, so that no residual lead is left inside. Should this not be done, then the next lead pellet inserted will not spread out and obtain a grip inside the recess.

The construction of the Kenter shackle is such that it is larger than

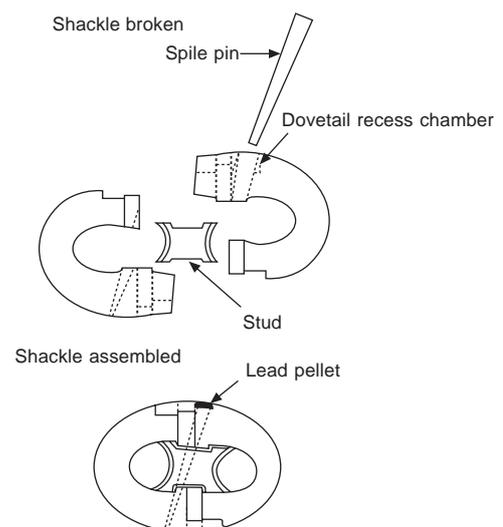


Figure 2.5 Kenter lugless joining shackle.

the common links but not by so much that it will not fit into the snug of the gypsy of the windlass or cable holder. However, care should be taken that it does not lie flat on the gypsy and cause jamming.

The main advantage of this type of joining shackle is that open end links are not required, as with the 'D' lugged joining shackle. In addition, all shackle lengths are the same, which ensures smoother working in the snugs of the gypsy. The shape of the Kenter lends itself to cable working, especially around and over the bow, and the tendency for it to catch is comparatively rare. As with other accessories, these shackles are tested, but because of their type of manufacture in nickel steel, they are not heat-treated.

'D' LUGGED JOINING SHACKLE

The 'D' lugged joining shackle is used extensively for joining the cable to the anchor in more modern vessels. In the past this type of shackle was used, as the Kenter lugless joining shackle is used today, in the joining of the shackle lengths of cable together. If it is to be used for this purpose, the rounded crown part of the shackle should always face forward, so that it does not foul the anchor when letting go.

It should be noted that the anchor crown shackle and the 'D' joining shackle face the opposite way to all other 'D' joining shackles in the cable. The mariner should be aware that the anchor, together with the initial joining shackle, is walked out of the hawse pipe prior to letting go (except in some cases of emergency). Consequently, the anchor crown shackle would not foul, but should other joining shackles be facing in this manner, there would be a distinct possibility of the lugs of the shackle catching on a snag in the letting-go operation.

When using these types of shackle between cable length, each cable length must have an open link at the ends. This is necessary to allow the passage of the lugs through the cable.

The construction of the 'D' lugged joining shackle is illustrated in Figure 2.6, where it may be seen that the bolt, generally oval in shape, is passed through the lugs and across the jaw of the shackle. A tapered pile pin of steel, brass or wood holds the bolt in position, a lead pellet being hammered home into a dovetail recess chamber to keep the pile pin from accidentally being expelled. The pile pin should be tapered to a ratio of 1:16, and wooden pins are made of ash or solid bamboo. When breaking the 'D' joining shackle, the bolt will be hammered from the unlippped end, causing the wooden pile pin to shear.

Should the pile pin be made of steel, then this must be expelled by using a punch and drift in a similar manner to that described for the Kenter shackle. The steel pin is generally found in the 'D' shackle joining the anchor cable to the anchor. When assembling these shackles, it is customary to give the bolt a smear of tallow to allow easy 'breaking' at a later date. Should the shackle become jammed and difficult to break, then it can be heated about the lugs. This will cause the lugs to expand, allowing the withdrawal of the bolt.

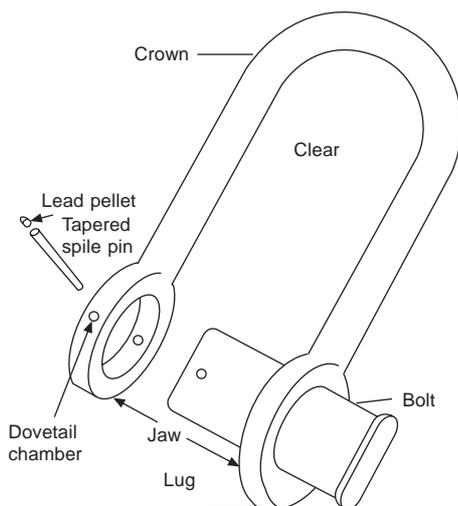


Figure 2.6 'D' lugged joining shackle.

SECURING AND STOWAGE OF ANCHORS

Alternative methods of securing anchor to cable are illustrated in Figure 2.7, and the operation of the cable in anchoring in Figure 2.8. There are many different designs of hawse pipe (Figure 2.9) in commercial use with the modern merchant vessel and the warship. The general arrangement is such that the axis of the pipe does not exceed 45° from the vertical; however, the most suitable angle is that which allows the easy lowering and restowing of the anchor. Many hawse pipe arrangements are recessed into the shell plate. This not only reduces drag effect, especially on high speed vessels, but should contact with another vessel or quay occur, damage is considerably reduced.

Many of the modern anchors, e.g. AC14 and Bruce (see Figure 2.27), have incorporated an anchor bed or special stowage frame fitment about the entrance to the pipe. This usually facilitates smoother operation when letting go and better securing for the anchors when not in use.

SECURING ANCHOR AND CABLE

Securing the bitter end of the anchor cable is illustrated in Figures 2.10 and 2.11, the fo'c'sle head in Figure 2.13 and anchor securing in Figure 2.13. Figure 2.15 lists chain cable accessories.

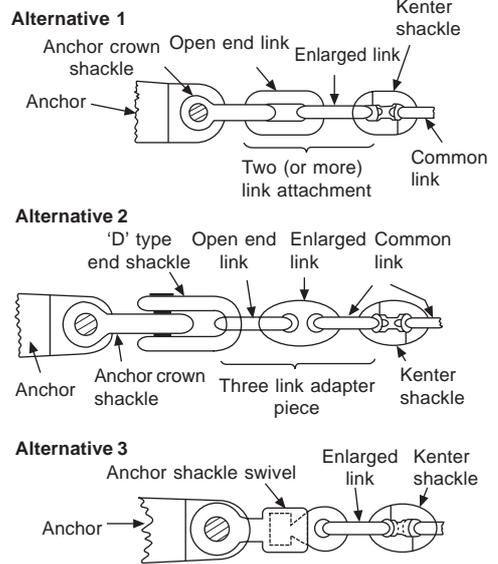
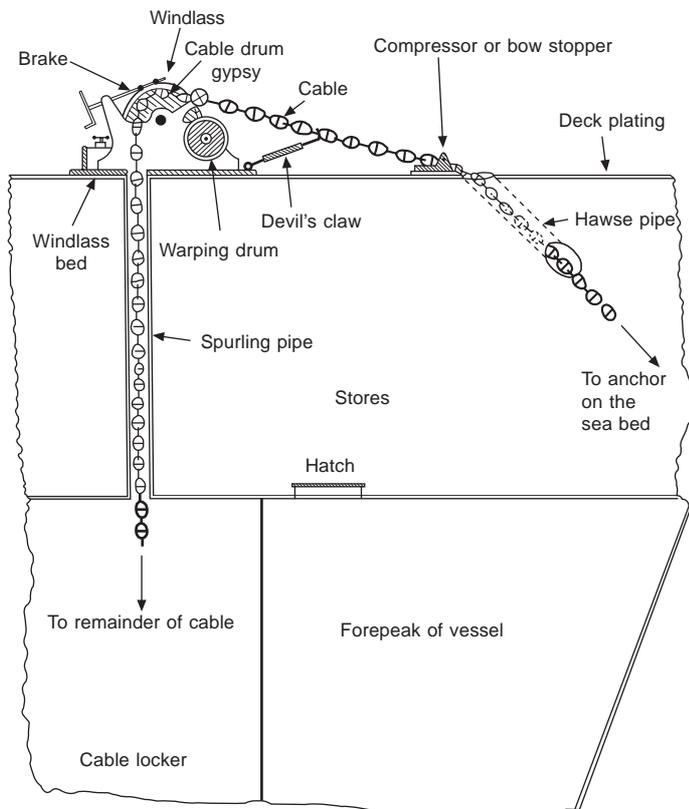


Figure 2.7 Securing anchor to cable.

Figure 2.8 Operation of cable in anchoring.

NB. The devil's claw shown in Figure 2.8 is shown for display purpose and would not normally be secured when the anchor is deployed.

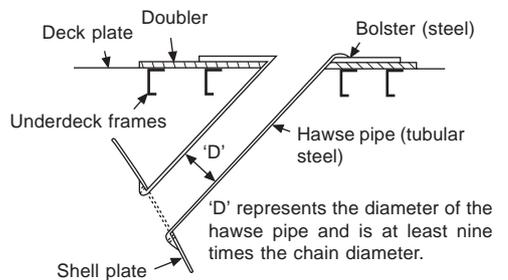


Figure 2.9 Arrangement of hawse pipe.

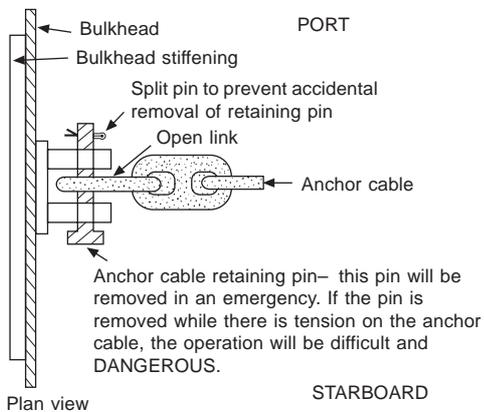


Figure 2.10 Internal securing of bitter end of anchor cable by Use of clench system inside cable locker. In some cases the link may pass through the bulkhead, the pin being placed on the other side. It is not then necessary for a man to enter the chain locker at all in order to slip cable.

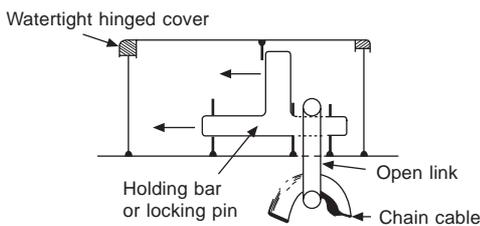


Figure 2.11 Alternative method of securing bitter end. An external fitment is situated outside and usually above the chain locker. The hinge cover when in position prevents removal of the locking pin holding the bitter end of the cable. This method allows the cable to be slipped without any person being ordered into the locker. The locking pin is removed by a simple sliding motion once the hinged cover has been lifted. The cable is then released and the bitter end is allowed to fall back into the locker.

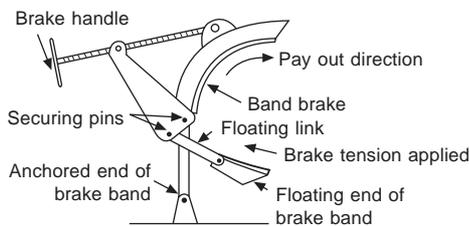


Figure 2.12 Windlass band brake system.

STEAM WINDLASS OPERATION

The following is a typical list of checks to be carried out before a steam windlass can be operated safely. You should consider what modifications to the list are needed to operate the type of windlass on your current vessel if it is different.

1. Inform the engine room of the requirement for steam to operate the windlass.
2. On the way to the windlass, ensure that the main deck steam-line valve is open (this may in fact be in the engine room), and drain deck line.
3. Check that the windlass stop-valve is open (usually found under the bed of the windlass inside the forecandle head), and ensure any lashings in the chain locker are removed.
4. Open the drain cocks of the cylindrical steam chests (normally two cocks per chest).
5. Ensure that the windlass operating valve is closed (stop-start control).
6. Wait until pure steam issues from the drain cocks – not a mixture of steam and water.
7. Close the drain cocks, and steam is now at the windlass head ready for use.
8. Ensure that the brake is firmly applied and that the windlass is out of gear.
9. Turn the windlass over by operating the start-stop valve.
10. Oil 'moving parts' as necessary to facilitate smooth running (obviously oil is applied to a stationary windlass for safety reasons).

Windlasses, winches and capstans are illustrated in Plates 4–8.

PREPARING ANCHOR FOR 'LETTING GO'

Once power has been obtained on deck, and the windlass has been oiled and checked, the anchors must be made ready to 'let go'. This operation must be carried out carefully and systematically to ensure that the 'letting go' operation will run smoothly. If a proper routine is established when time is not limited, the anchoring procedure is more likely to go smoothly and quickly when an emergency occurs.

Once deck power is obtained, the following operations are carried out:

1. Check that the windlass brake is on and holding and that the windlass is in gear.
2. Remove the hawse pipe covers.
3. Remove the devil's claw.
4. Remove any additional lashings.
5. Remove the bow stopper, guillotine or compressor.
6. Take off the brake and walk the cable back a short distance in order to break the cement pudding inside the spurling pipe. Modern ships often have spurling pipe covers instead of cement seals. If fitted these should be removed.
7. Clear away old cement and throw overside.

8. Walk back on the cable until the anchor is out, clear of the hawse pipe and above the water surface, then heave a few links back to ensure cable will run.
9. Screw the brake on hard and check that the brake is holding.
10. Take the windlass out of gear, leaving the anchor holding on the brake. Check that it is out of gear by turning power on briefly. Report to the Bridge that the anchor is on the brake and ready for letting go.

CABLE HOLDERS

Cable holders (Figure 2.16) are often fitted to large merchant vessels as an alternative to the windlass, and, with recent developments, may be seen on passenger vessels. They have also been popular with warships for some considerable time because they are compact and lie low on the deck.

Early models employed a cable drum (gypsy) without the valuable addition of warping facilities. Modern versions include a warping drum geared to the centre-line axle. This can subsequently be de-clutched when working anchor cables. A separate braking system is incorporated in each cable holder, similar to that fitted to the windlass.

Anchor securing arrangements are similar, except that the bow stopper is usually situated closer to the hawse pipe than to the cable holder. A devil's claw or slipping arrangement is sited between the bow stopper and the holder.

Where cable holders are used, the lead of cable is always close to the deck. To prevent excessive wear to deck plating from cable friction, a 'Scotsman' is a common fixture to provide the required protection.

Variations of combined capstan/cable holders are available on the commercial market, powered by steam or, more commonly, electricity.

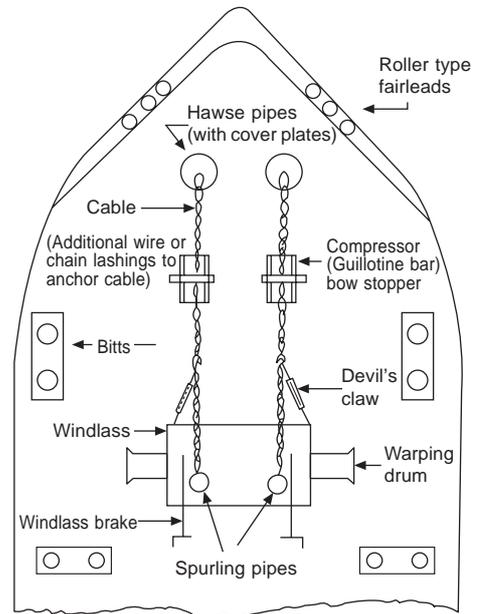
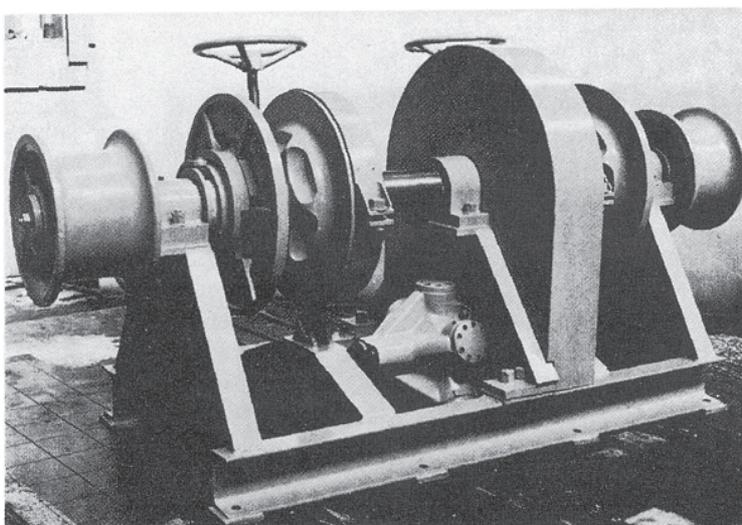
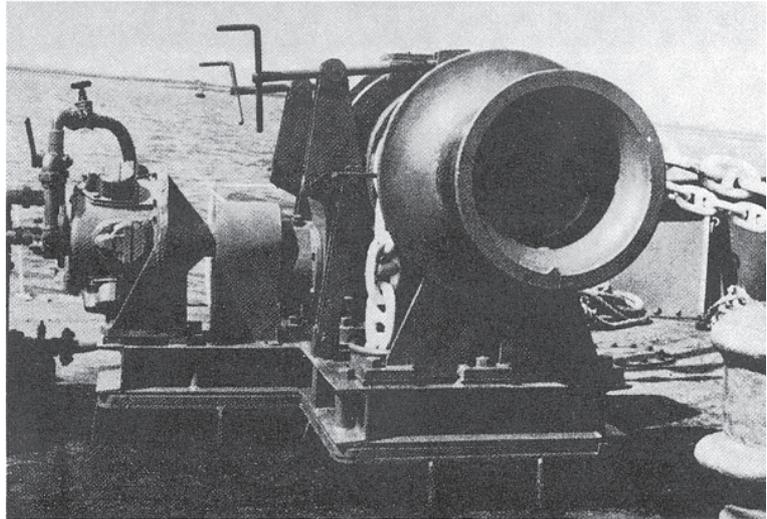


Figure 2.13 Fo'c'sle head anchor and cable arrangement (plan view).

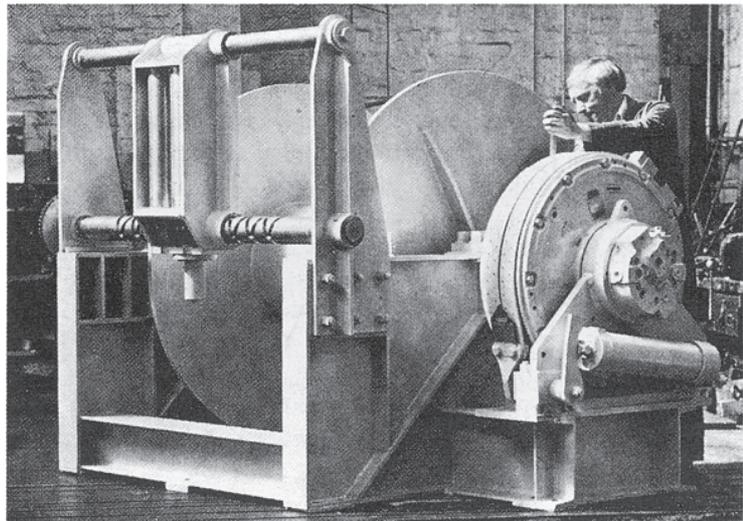


4. Hydraulic windlass before being fitted, showing warping drums, gear plates, gypsy and exposed snug to accommodate anchor cable, band brakes and brake control wheels. Manufactured by Robertson's of Fleetwood.

5. Pneumatic windlass showing band brake controls exposed and anchor cable passing over gypsy and entering spurling pipes.



6. Single barrel hydraulic mooring winch, with 5 tonne to 40 tonne pull at design speed of 15 to 10 revolutions per minute, depending on size and weight of material being heaved.

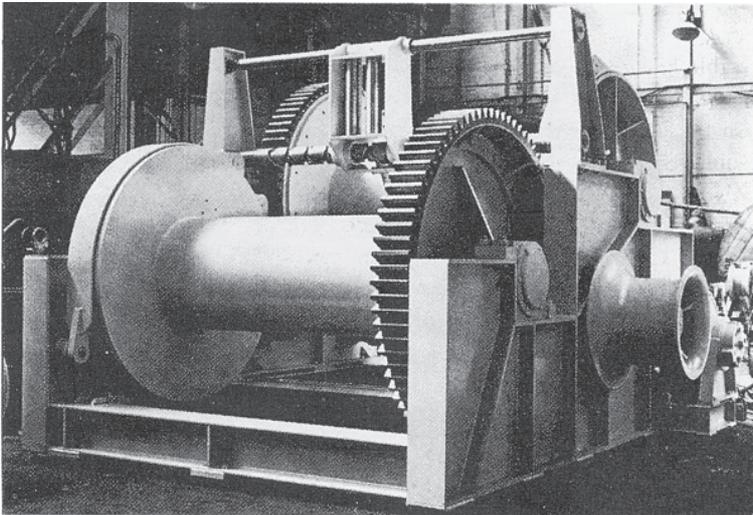


As with other similar deck machinery, additional strengthening of deck areas about operational sites is required to accommodate excessive load.

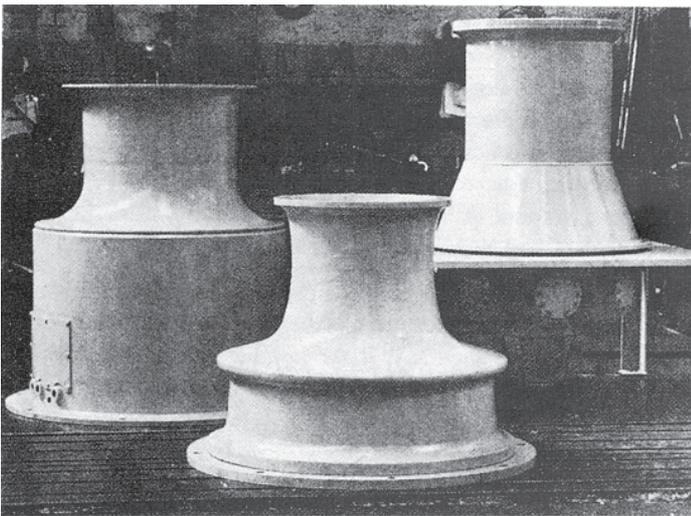
PROCEDURE FOR COMING TO ANCHOR

The preliminaries to the operation include careful scrutiny of the chart of the area where the vessel is proposing to anchor, and consideration of the depth of water and the holding ground with the view to determining the amount of cable to use (Figure 2.17). The amount will be determined by the following:

1. Depth of water.



7. Double barrel anchor-handling/towing winch of a type extensively fitted in offshore supply vessels. Designs include a four-speed range and automatic fail-safe hydraulic braking systems.



8. Hydraulic capstans before being fitted, showing underdeck motor, single drum and vertical capstan.

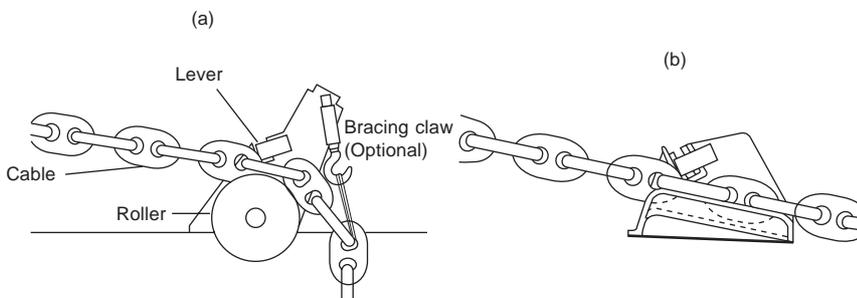


Figure 2.14 (a) Self-holding and automatically releasing roller bowstopper, manufactured and produced by Clark Chapman Ltd. (b) Self-holding and automatically releasing track bowstopper.

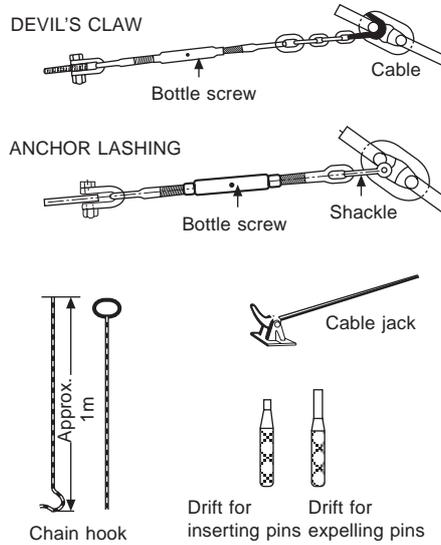


Figure 2.15 Chain cable accessories.

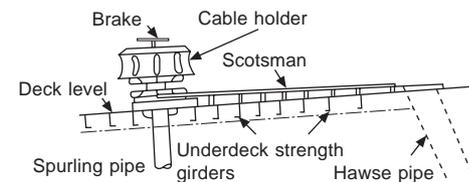
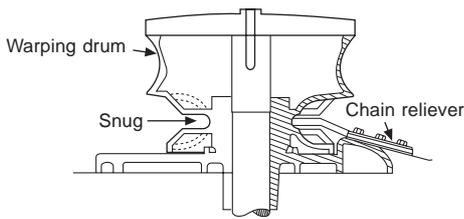


Figure 2.16 Cable holders.

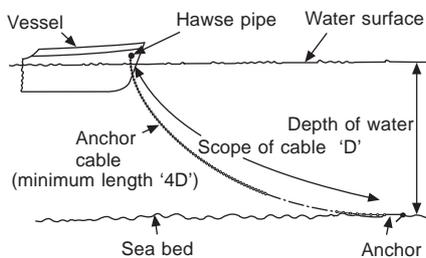


Figure 2.17 Amount of cable to use when anchoring.

2. Type of holding ground, good or bad.
3. Length of time the vessel intends to stay at anchor.
4. Sea room available for circle of swing.
5. Expected weather conditions.
6. Strength of tide, if any.
7. Draught and amount of hull exposed to the wind.
8. Type of anchor and its holding power.

These factors will vary with each case and previous experience; however, as a general rule, four times the depth of water may be taken as a working minimum. This would change, say, if the holding ground was bad, the weather deteriorating, and you were expected to remain at anchor for a long period of time.

The Anchor Plan

An anchor plan should be established between the interested parties, namely: The Ships Master/Captain or Offshore Installation Manager (OIM), the Officer in Charge (OiC) of the anchor party, or the Master of Anchor Handling Vessel (AHV). It would be expected that these key personnel would inform relevant crew members through an established chain of command, regarding relevant criteria.

In the construction of any anchor plan the following items must be worthy of consideration:

1. The intended position of anchoring of the vessel.
2. The available swinging room at the intended position.
3. The depth of water at the position, at both High and Low water times.
4. That the defined position is clear of through traffic.

5. That a reasonable degree of shelter is provided at the intended position.
6. The holding ground for the anchor is good and will not lend to 'dragging'.
7. The position as charted is free of any underwater obstructions.
8. The greatest rate of current in the intended area of the anchorage.
9. The arrival draught of the vessel in comparison with the lowest depth to ensure adequate under keel clearance.
10. The choice of anchor(s) to be used.
11. Whether to go to 'single anchor' or an alternative mooring.
12. The position of the anchor at point of release.
13. The amount of cable to pay out (scope based on several variables).
14. The ship's course of approach towards the anchorage position.
15. The ship's speed of approach towards the anchorage position.
16. Defined positions of stopping engines, and operating astern propulsion (single Anchor Operation).
17. Position monitoring systems confirmed.
18. State of tide ebb/flood determined for the time of anchoring.
19. Weather forecast obtained prior to closing the anchorage.
20. Time to engage manual steering established.

When anchoring the vessel it would be usual practice to have communications by way of anchor signals prepared for day and/or night scenarios. Port & Harbour Authorities may also have to be kept informed if the anchorage is inside harbour limits or inside national waters.

NB. Masters or Officers in Charge, should consider that taking the vessel into an anchorage must be considered a Bridge Team operation.

Single Anchor – Procedure

The master, or pilot, should manoeuvre the vessel to the desired position, and take all way off, so that the vessel is stopped over the ground. She should be head to the wind and/or tide, and have her anchor walked back out of the hawse pipe, on the brake ready for letting go. The Bridge should be informed that the anchor is on the brake of the windlass, or cable holder, and is ready for the order to 'let go'.

The engines should be operated to give stern way to the vessel. The Master should check overside and see the stern wake, about half-way up the vessel's length, and know that stern way is being made through the water, before giving the order to 'let go'. The officer in charge of the anchor party should order the brake to be taken off and allow the cable to run out with the weight of the anchor. The idea is to lay the cable out in length along the sea bottom, and not cause it to pile up on itself.

The officer in charge should start to apply the brake once enough cable has run out to prevent it falling on top of the anchor. The procedure is to check on the cable periodically, by applying the brake, while the vessel drops astern, either under engine power or through the action of the tide, and lays the required length of cable.

Communication from the fo'c'sle head to the Bridge should be

maintained by walkie-talkie, loud hailer/phone, or by the ringing of the ship's forward bell.

Bell Signals

When heaving in the cable or letting go, the bell should be struck once for every shackle's length, e.g. three shackles, three strokes of the bell.

When the anchor breaks clear and becomes 'anchor aweigh', then a rapid ringing of the bell will indicate to the Bridge that the anchor is aweigh. Prudent Chief Officers tend not to ring anchor aweigh until the anchor is sighted and the flukes clear the water, in case the anchor has become fouled in any way with, say, warps or power cables.

Marking of Anchor Cable

As the anchor is let go, the officer in charge of the anchor party will require to know the amount of cable being paid out. Each shackle length will be identified by the joining shackle, which is a larger link than the other links of the cable. The individual shackles will be distinguished by the number of studded links either side of the joining shackle. In the example given in Figure 2.18 the fourth shackle is used, and the fourth studded link from the joining shackle will be bound around the stud with seizing wire. This identification by means of seizing wire will be seen to mark the fourth shackle on both sides of the joining shackle. Seizing wire is used to enable the officer in charge to feel about the stud of the link and so locate, by his sense of touch, how far away the marked link is from the joining shackle – very useful during the hours of darkness. Seizing wire is used because it is quite robust and will stand a fair amount of wear and tear when the anchor is being let go, whereas the paint mark (see below) may tend to chip, or flake off, after a short period of time.

The length of cable between the seizing wire portions is painted a bright distinctive colour, e.g. white, so that each shackle length may easily be located and acknowledged when operating anchors during the hours of darkness. Some ships often paint the joining shackle a different colour to highlight the position of the joining shackle.

If a 'D' lugged joining shackle is used to join cable lengths together (Figure 2.18(b)), then open links are found either side of the 'D' shackle. These open links must not be counted in the marking of the cable with seizing wire. Only studded links away from the joining shackle are to be counted.

Anchor cables should be checked whenever an opportunity presents itself, as in dry dock where the cables can be ranged along the bottom of the dock and inspected with ease.

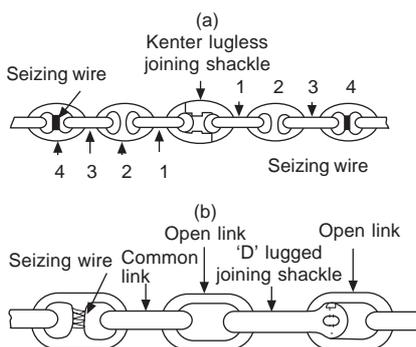


Figure 2.18 Marking anchor cable: (a) fourth shackle of cable; (b) second shackle length by means of 'D' lugged joining shackle. Open links on either side of the joining shackle are ignored for the purpose of marking cable in this case.

CLEARING AWAY ANCHORS

The term 'clearing away' means preparing the anchor to let go, though different ships have different ways of operating. Most vessels are now equipped with hawse-pipe covers – sliding metal covers which must be

removed in order for the cable to run clear. Anchor lashings may be attached to the bow stopper claw or secured from deck lugs through the cable itself. These must be released and cleared away, as with the devil's claw, if fitted. The compressor or guillotine bar should be removed from the cable, together with any lashings which may have been applied inside the cable locker.

Past and Present Practice

A lashing in the cable locker served to stop the cables banging together when the ship was at sea. In bygone days the sailors used to sleep in the fo'c'sle head area, and the banging cables tended to keep them awake. Hence they were lashed secure.

The more up-to-date thinking is that if the cable is lashed the chance of a bight of cable being buried by the remainder of the pile of cable in the locker will be reduced. This was especially so in the early days of non-self-stowing cable lockers.

Another reason, which is now by far the most popular, is that when the spurling pipes are sealed with cement, this cement plug and seal would be prevented from cracking up, when the vessel was in a seaway, by the secure lashing of the two cables together inside the cable locker.

Mariners should be aware that the practice of lashing cables in the locker is no longer common practice on modern vessels.

Spurling pipes must be sealed, but hinged slide design steel plates are now by far the most popular method of making them watertight. Should these steel plates not be fitted, then a pudding plug, made up of rags or cotton waste, should be forced into the aperture of the spurling pipe. Cement mix, of four of sand to one of cement, should be poured over the pudding, about the anchor cable. This cement cover should be of such thickness that any movement of the anchor cable in the spurling pipe would not cause the cement to break. The purpose of the pudding is to stop the cement from dropping through to the cable locker, and also to give it something to set on.

ANCHOR TERMINOLOGY

Anchor A-Cockbill

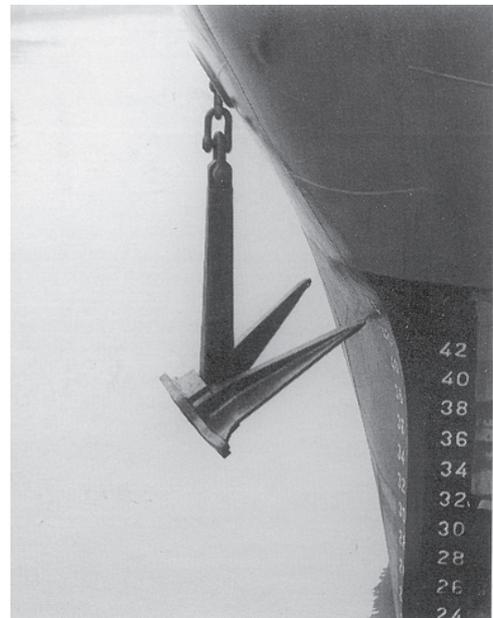
When the anchor is hanging vertically from the hawse pipe, with the flukes turned into the ship's side (Plate 9). In this position it will not stow correctly in the hawse pipe.

Anchor Aweigh

The anchor is said to be 'A-Weigh' at the moment it is broken out of the ground and clear of the sea bed.

Anchor Buoy

A buoy used to indicate the position of the ship's anchor when on the bottom.



9. Anchor a-cockbill.

Anchor Coming Home

When the anchor is being drawn towards the ship in the operation of heaving away, by means of the windlass or cable holder/capstan, the anchor is said to be coming home. Instead of the ship being drawn towards the anchor, the reverse is happening.

Anchor Dragging

The anchor is said to be dragging when it is not held in the sea bed. It is said to bite well when it has a good hold in the ground. The vessel is 'dragging her anchor' if she moves her position while dragging the anchor over the sea bed.

Anchor Warp

The name given to a hawser or rope when it is attached to the anchor and used as a temporary cable.

Brought Up

A vessel is said to be brought up when her way has stopped and she is riding to her anchor, with the anchor holding. The terms 'come to' and 'got her cable' are sometimes used to mean the same thing. The officer in charge of an anchor party will know when the vessel is brought up, by the cable rising up from the surface towards the hawse pipe when the brake is holding it. The vessel should then move towards the anchor, causing the cable to drop back and make a catenary (Figure 2.19).

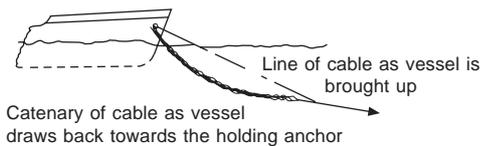


Figure 2.19 A vessel brought up.

Cable Clench

A strong steel forged fitting in the cable locker for securing the 'bitter end' of the cable (see securing of anchors, p. 33).

Cable Jack

A device for lifting the cable clear of the deck (see anchor accessories, p. 38).

Cable's Length

A length of 600 ft, or 100 fathoms (183 m).

Cat the Anchor

The anchor is said to be catted when hung off, from what used to be called the clump cathead. More modern vessels will be fitted with a pipe lead set back from the line of the hawse pipe and used for the purpose of 'hanging off an anchor'. Found in practice when mooring to buoys by means of mooring shackles with the cable.

Chain Hook

A long iron hook used for the manhandling of cable links (see chain cable accessories, p. 38).

Cross

Occurs when the cables are fouled as in foul hawse, when the ship has swung through 180° a cross being formed with the two cables (see Figure 2.20).

Drop an Anchor Under Foot

Letting an anchor go to the bottom, then holding on to the brake. This is sometimes done to steady the ship's head and prevent her yawing about when lying to a single anchor. Care must be taken in this operation that the second anchor is let go when the riding cable is growing (see below) right ahead, and not when it leads off the bow.

Elbow

Occurs when the cables are fouled as in 'foul hawse'. When the ship has swung through 360°, an elbow is formed in the anchor cables (see Figure 2.20).

Foul Anchor

The term used to describe the anchor when it has become caught on an underwater obstruction. The flukes of the anchor often become fouled by an old hawser or cable, obstructing its normal use.

Foul Hawse

This term is used to describe the crossing of the anchor cables, when both cables are being used at the same time, as with a running, standing or open moor, owing to the uncontrolled swinging of the vessel when anchored with both anchors (moored).

Grow

The cable is said to grow when the exposed part of the chain above the surface, is seen to expand towards the anchor.

Gypsy

The vertical wheel on the windlass which the cable passes over. The cable is held in the segments of the wheel known as the 'snug'. The gypsy is held by the clutch plate (when in gear) or by the brake (when about to be let go).

Hawse Pipes

The two pipes on either bow which accommodate the bow anchors. Some vessels may be equipped with a stern anchor. The term hawse pipe is in general use for the stowage space for the anchors of a vessel.

Hove in Sight

When the anchor is hove home, it is 'sighted and clear' at the point when the anchor crown shackle breaks the surface of the water. A prudent

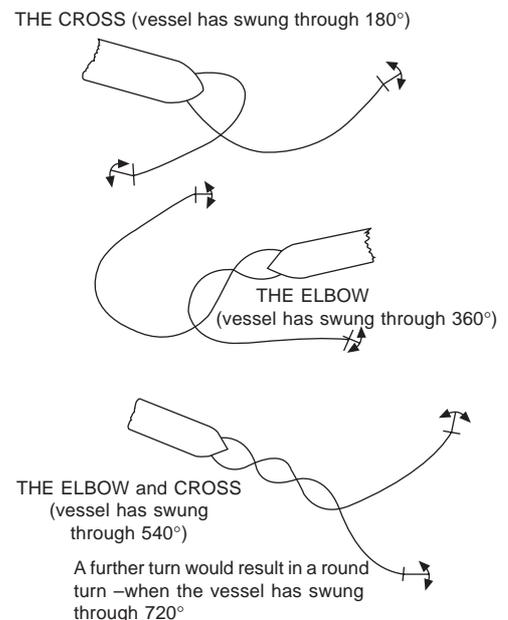


Figure 2.20 Clearing foul hawse.

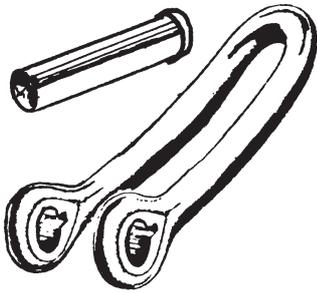


Figure 2.21 Joggle shackle.

officer would not consider that the anchor is clear until he sees that the flukes are clear. On the same basis an officer in charge of an anchor party tends not to ring anchor aweigh until he sees the anchor is hove in sight and clear.

Joggle Shackle

May be described as a long bent shackle, used for hauling cable round the bow (Figure 2.21). Sometimes encountered when clearing a foul hawse or other similar operation in moving of cable.

Kedging

Moving a vessel by means of small anchors and anchor warps.

Long Stay

The term applicable when the cable is leading down to the water close to the horizontal, with weight on it. A good length of the cable is exposed.

Moored

A vessel is said to be moored when she has two anchors down to the sea bed.

Ream a Shackle

To clean away any residual lead left inside the lug of a shackle after the lead pellet and spile pin have been removed, by use of a reaming tool.

Render Cable

To apply the brake lightly so that when weight comes on the cable it will run out slowly.

Round Turn

Occurs when the cables are fouled as in 'foul hawse', when the ship has swung through 720° or twice round.

Scope

Is the name given to the amount of anchor cable payed out from the hawse pipe to the anchor crown 'D' shackle.

Shackle of Cable

The length of a shackle of cable is 15 fathoms (90 ft). It is defined by the length of cable between the joining shackles (previously a length of $12\frac{1}{2}$ fathoms).

Sheer

When applied to a vessel at anchor, sheer is an angular movement of the vessel about the hawse pipe point, it can be deliberately caused by applied helm to port or starboard.

Sheet Anchor

An additional anchor carried by larger vessels, a practice largely discontinued (not to be confused with the spare anchor carried by the majority of vessels).

Shorten Cable

To heave in a portion of the cable, so reducing the scope.

Short Stay

The cable is said to be at short stay when the anchor is hove in close to the ship's side and not over-extended. The cable is not up and down in this position.

Snub

To snub the cable is to stop the cable running out by applying the brake. A vessel is said to snub round on her anchor when she checks the paying out of the cable by applying the brake on the windlass, so causing the cable to act as a spring, turning the bow smartly in the direction of the cable.

Spurling Pipes

Termed 'navel pipes' in the Royal Navy, the cable passes through these pipes from the windlass or cable holder to the cable locker.

Surge

To allow the cable or hawser to run out under its own weight. The term is often used when handling mooring ropes on drum ends. (You should not surge on man-made fibre ropes, because of the possibility of heat/friction causing the yarns/strands to fuse.)

Tide Rode

A vessel is said to be tide rode when she is riding at anchor head to tide.

Up and Down

The cable is said to be up and down when the angle the cable makes with the water surface is 90°, usually just before anchor aweigh.

Veer Cable

To pay out cable under power, by walking back the gypsy of the windlass.

Walk Back the Anchor

To lower the anchor under power.

Wind Rode

A vessel is said to be wind rode when she is riding at anchor head to wind.

Yaw

A vessel is said to 'yaw' when at anchor when she moves to port and starboard of the anchor position under the influence of wind and/or tide. Yawing should not be confused with sheering.

WATCH AT ANCHOR

Before the vessel is brought to an anchorage, the Master and engine-room staff should be informed of the estimated time of arrival (ETA), and time of anchoring. An anchor approach plan should be prepared, and speed reduced in plenty of time to assess the approach features and the anchorage area, including depths for echo-sounder. A responsible officer should be fully informed of details regarding amount of cable, depth of water and holding ground, and brief the anchor party accordingly. Power on deck should be obtained in ample time and the anchor walked back before the approach is started. Anchor signals or lights, which should have been tested prior to use, should be made ready.

The state of weather, with particular attention to wind, should be kept under continual observation. State of visibility, traffic density, and the proximity to navigation hazards should be assessed before entering the area for anchoring. Availability of sea room, especially to leeward, should be considered before letting go. The state of tide and current, times of high and low water, and time limits of the vessel when swinging should all be studied.

Officer of the Watch

The officer of the anchor watch should have all relevant information regarding the amount of cable paid out, and the estimated position of the anchor. (An anchor buoy often indicates the approximate area of the anchor position, but is only a guide.)

The officer's duties include the checking at regular intervals of the ship's position. This may be carried out by observing compass bearings of fixed objects ashore or prominent landmarks. These bearings laid on the chart define the vessel's position. Similar checks may be made by using radar, the bearing cursor, and the variable range marker. However, the mariner should not rely solely on radar in case of instrument malfunction. Transit bearings give a good indication, but the objects used should be spread well apart so that any movement of the vessel would open up the transit objects quickly and allow detection of the vessel's change in position. The purpose of checking the anchor bearings is to ascertain the ship's position, to ensure that she is not dragging her anchor, so moving her position over the ground.

There are other methods of detecting whether the vessel is dragging. For example, secure a hand lead overside from the bridge wing, and let the lead sit on the bottom; if the vessel is dragging her anchor, the lead line will start to lead forward. This would indicate to the observer that the vessel was dropping away from the lead sitting on the bottom.

Transit Bearings

Extensive, practical use of transit bearings should be made by the officer of the watch, when the vessel is at anchor, especially when 'beam transits' can be obtained. This is not to say that watch officers should rely solely on good transit marks. They should always employ whatever means at their disposal to ascertain the ship's position, checking and double-checking at regular intervals.

General Precautions

The officer of the watch should also ensure that a deck watch is kept when the vessel is at anchor. Detection of the vessel dragging may be ascertained by personnel engaged on this duty 'feeling the cable'. If the vessel is dragging her anchor then vibration from the anchor bouncing over the sea bottom will travel up the length of the cable, especially if the sea bottom is of a hard, uneven nature.

The deck watch should also be aware that unauthorised personnel may try to board the vessel in certain regions of the world. Theft and piracy are rife today in some underdeveloped countries. Access is often gained by climbing the anchor cable, or by grapple over the stern.

The officer of the watch should ensure that all anchor signals are displayed correctly, and, if oil lights are used, that these remain alight throughout the hours of darkness. Deck lights should be used whenever a vessel is at anchor, together with overside lights.

Correct fog signals should be sounded if the visibility closes in. Radars should be operational if necessary and a sharp lookout kept at all times. VHF radio should be on, and a listening watch continually kept on the local port channel or channel 16.

If in any doubt, the Master should be informed at the earliest possible moment. Should the vessel drag her anchor, the Master must be informed immediately. The engine room should be kept ready for immediate notice in order to manoeuvre the vessel out of any difficulty, should the need arise. A constant check on weather conditions should be kept, and all changes and incidents noted in the log book.

When handing over the watch to another officer, the officer of the watch should inform the relieving officer of all relevant details regarding the anchor and cable, weather reports, anchor bearings, ship's position, depth (from echo-sounder). State of tide, time of expected swing, and expected circle of swing should all be marked on the chart.

Another Vessel Dragging Towards Your Ship

The options open to the mariner are somewhat limited. A junior officer faced with the situation should inform the Master immediately. Subsequent actions include drawing the attention of the other vessel to the fact that she is dragging her anchor, in case the incident is undetected, make ready own engines, and send forward an anchor party.

Drawing Attention to the Situation

When vessels are in sight of one another (Rule 34(d) of The Regulations

for the Prevention of Collision at Sea), or are approaching each other, and from any cause either vessel fails to understand the intention or actions of the other, or is in doubt whether sufficient action is being taken by the other to avoid collision, the vessel in doubt shall immediately indicate such doubt by giving at least five short and rapid blasts on the whistle. Such signals may be supplemented by a light signal of at least five short and rapid flashes.

The instructions give the officer of the watch a directive for his actions on the Bridge. However, it should be borne in mind that this signal is only appropriate when the vessels are in sight of each other. When vessels' visibility is restricted (Rule 35f) a vessel at anchor may, in addition, sound three blasts in succession – one short, one prolonged, and one short blast – to give warning of her position and the possibility of collision to an approaching vessel.

Stand by Engines

Bearing in mind that 'finished with engines' should not be ordered when the vessel anchors. Stand by engines must be ordered at a very early stage in order to gain any advantage, since the engine-room staff may require a period of notice to have engines ready. If this is the case, then the sooner main machinery is made ready to manoeuvre the better.

It could well be, that the Master may decide to steam over his own anchor cable, choosing this alternative to an anchor operation. Depending on the circumstances it would be unlikely that the Master would order astern propulsion, as this would most certainly put excess strain on the cable. However, the loss of an anchor would be a secondary consideration to an imminent collision.

Anchor Party Forward

Should the main engines not be readily available, then the moving of the vessel by means of anchors must be of prime consideration. The alternatives are (1) to pay out more cable and increase the scope, or (2) to heave in on the cable and decrease the scope. Whichever is chosen will depend on the position of the approaching vessel, and the circumstances at the time.

If the cable is shortened and the ship begins to drag her anchor, it may be possible to 'sheer' her, using the helm to clear the approaching vessel. As a last resort, and if time permits, the cable could always be slipped from the locker. The end of the cable should be buoyed to aid recovery at a later date.

Use of VHF Radio

Attention to the fact of dragging anchor could be made by VHF radio. This is all very well if both vessels are equipped with VHF and that it is working, in a switched 'on' condition, and on the same channel. But extreme care should be observed when engaged in communication by VHF that both participants have identified themselves. Mariners may find themselves in communication with a third party within range of the VHF radio who is in no way connected with the operation.

Mariners are further reminded of the wording and the content of Rule 36 of the Collision Avoidance Regulations, regarding Signals to Attract Attention, which may be made by any vessel.

DEEP WATER ANCHORING

Should it become necessary to anchor the vessel in an emergency, or in anchorages such as the Norwegian fjords, the Master may be forced to a deep water anchorage. Should this occur, the anchor should not be let go in the normal manner, but walked back all the way to the sea bed.

The anchor party should have an idea of the depth of the water, and be able to estimate when the anchor is on the bottom. As the vessel drops astern once the anchor begins to hold, the cable should be seen to grow slightly. However, because of the considerable weight of cable in the vertical up and down position, it will be increasingly difficult to see the cable snatching or growing to indicate that the vessel is brought up.

The officer in charge of the anchor party should be aware of the total length of cable that the vessel is equipped with to each anchor. Bearing this in mind, a close watch should be kept on the amount of cable being payed out. Many vessels have the joining shackle of the last length (shackle) of cable painted a distinctive colour for this reason.

When lowering away, under no circumstances should the anchor cable be allowed to run out from the brake. Control could be lost with the excessive weight of cable in use, resulting in possible loss of anchor and cable, together with serious damage and possible injury.

LAYING/CARRYING OUT ANCHORS

Only exceptional circumstances would generally dictate this operation, such as stranding or beaching. Success will be dependent on several or possibly all the following points:

1. Size and weight of anchor.
2. Size, type and weight of cable or warp.
3. Size and capabilities of ship's own boats.
4. Depth of water.
5. Type of holding ground and geographic features.
6. Experience of crew members.
7. Prevailing weather at time of operation.
8. Availability of specialised equipment, including tugs.

With the ever-increasing number of large vessels in operation the exercise of carrying out an anchor would in many cases become irrelevant, unless ships are specifically equipped to do the job. An example of this makes this apparent if, say, a 20 tonne anchor of a VLCC was to be carried out by means of ship's boats. Even with large boats the gunwales would be nearly awash, and even if the anchor was allowed to submerge, in most cases (depending on the type of anchor) little benefit would be gained from buoyancy effects.

Vessels carrying very large anchors in the 15–25 tonne range would have little alternative to obtaining the assistance of a tug or other similar craft, capable of accepting and capable of releasing such a load. Masters engaged on such operations should bear in mind the additional weight factor of cable and/or warps, together with shackles etc.

With a smaller vessel equipped with the corresponding weights of anchors, i.e. under 15 tonnes, the possibility of employing one as a stream or kedge anchor is not beyond the bounds of feasibility. The ship will be required to have lifting gear capable of hoisting the anchor, together with boats capable of transporting it.

Special operations like this will, of course, depend on the circumstances at the time, but as a general rule two boats will be required to support an anchor of any size. Slipping arrangements must be adequate to release the anchor from between the boats, in a controlled manner. Unless both boats are 'motor boats', it is suggested that steerage and propulsion should be made under oars.

When letting go a stream anchor, a long enough lead must be used, and allowance must also be made for the anchor to drag before becoming 'hung up'. A mistake in the position of letting go will, without doubt, double the work load, for what is, in any event, a lengthy operation.

Safety factors to be taken into consideration should be:

- (a) Commence operations at a time to coincide with a maximum period of daylight.
- (b) Limit the number of men in the boats, when carrying out, to an essential number.
- (c) Use experienced seamen who have been briefed in full about the operation.
- (d) Lifejackets on relevant personnel, especially in the boat.
- (e) Buooy the anchor, prior to letting go (an additional boat may be useful here).
- (f) Use stopper arrangement over the warp or cable to prevent whiplash on release.
- (g) Any strongbacks used should be braced and of adequate strength.
- (h) Prior to release, check that the warp will fall clear of boats.

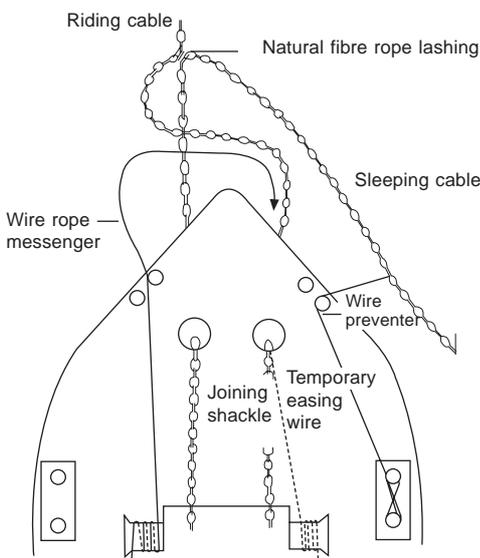


Figure 2.22 Foul hawse.

CLEARING A FOUL HAWSE

The object of this operation is to remove the foul turns in the two anchor cables caused by the vessel turning with the tide change continually in the same direction (Figure 2.22). It is a lengthy operation and should be started as soon as the vessel has swung and is riding at her new position; this will provide a six-hour interval before the tide turns again and the vessel assumes another position. To this end all preparatory work should be carried out before the vessel swings.

Position of the Lashing

Although in the following procedure it is said that the cables should be hoisted up to bring the foul turns above the water, and the lashing should

be placed about the two cables below the turns, the mariner should be aware that there is a case to be made for securing the lashing above the turns. Should there be any doubt that the tidal stream may catch the vessel and cause her to swing during the operation, then her sleeping cable could well become the riding cable. If this occurred and the lashing was secured below the turns, then the full weight of the vessel at anchor would come on to the fibre lashing, a highly undesirable condition.

The lashing itself should be a natural fibre lashing, as it will cut easily, rather than a synthetic rope, which may cause the blade to slip on its surface. If a knife and manhelp are not to be used to cut the cables adrift, then soak the lashing in petrol or other flammable liquid and burn the lashing adrift. This procedure may be assisted by heaving on both cables to break the lashing, as it becomes weaker. A manhelper is a long wood pole, usually of bamboo. Paint brushes, metal wood scrapers, knives etc. are often secured to the end of the pole for the purpose of extending the handle of the implement.

Securing is achieved by lashing the tool/implement to the pole by using two jubilee clips.

This lashing, depending on its position, may be secured from either a boat or by a man in a bosun's chair. Should the latter be used, extra care should be taken to see that the man is removed from the chair before the cables splay apart.

Alternative Method

A method mainly employed by the Royal Navy was to use two wires, one from each bow, as messengers about the fouled cables. This method is effectively the same as the one described, but the use of two wires tends to expedite the work.

Clearing a Foul Hawse – Procedure (Figure 2.22)

1. Heave up on both cables to bring the foul turns above the water and lash both cables together below the turns with a natural fibre lashing. This lashing will prevent the turns from working themselves further down the cable.
2. Pass a wire preventer around the sleeping cable, down from the turns. This will reduce the weight on the turns, and serve to secure the sleeping cable should the end be lost. This preventer should be passed in such a manner that it may be slipped from the deck when the foul is cleared.
3. Walk back on the sleeping cable to bring the next joining shackle conveniently forward of the windlass. Rig a temporary easing wire to a point forward of this shackle, so that it can take the weight of the sleeping cable when the shackle is broken.
4. Reeve a wire rope messenger from the windlass drum overside; the wire should be a cargo runner or other similar wire.
5. Take a half turn about the riding cable with this cargo runner wire. This turn should be made in the opposite direction to the foul turns in the cables.

6. Pass the end of the wire messenger up through the hawse pipe of the sleeping cable and secure it to the end of the sleeping cable.
7. Heave away on the wire messenger, and at the same time ease out on the easing wire, heaving the end of the sleeping cable up towards the fairleads, thus removing a half turn from the fouled cables.
8. This procedure should be repeated, removing half a turn at any one time, until the fouled cables are clear.
9. When all the turns are clear, haul in the sleeping end of the cable and rejoin with the joining shackle on deck.
10. The preventer wire should be slipped and cleared; the lashing should be cut by using a sharp knife with a manhelper. Heave away on both cables, picking up any slack.

TO WEIGH ANCHOR BY DECK TACKLE

This operation would be necessary if the windlass for some reason could not be used.

A heavy duty tackle, of safe working load minimum 15 tonnes, should be secured to bitts about the break of the fo'c'sle head. This tackle should be sited as near as possible to give a clear lead, lying as near parallel to the line of cable as is practical. A heavy duty wire pendant should be shackled to the moving block of the deck tackle (see Figure 2.23). A joggle shackle, if carried, should secure this pendant to the cable, while the downhaul of the deck tackle is led to a cargo winch drum.

The length of the operation will depend on the amount of cable that is paid out, but in any event the task will be made easier by an overhauling purchase rigged on the opposite side. The purpose of this is to reduce the work of manually overhauling the deck tackle as each length of cable is hove in.

There will no doubt be variations of this method, and the position of deck tackle, overhauling purchase, snatch blocks etc. will be dependent on deck fittings. The idea of the heavy duty pendant is that this will not foul any deck fittings. If the tackle was secured directly to the cable, then its passage in heaving on the cable might become restricted by the sheer size of the blocks.

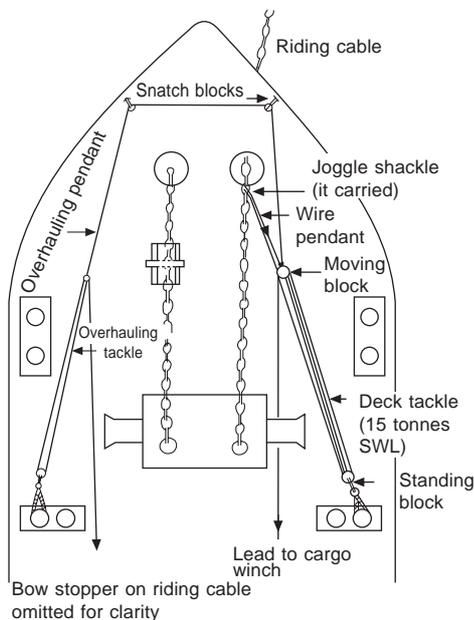


Figure 2.23 Weighing anchor by deck tackle.

Alternative

If the vessel is fitted with a windlass, a friction drive may be set up between one of the forward cargo winches and the drum end of the windlass. However, should cable holders be fitted, this may not be practical. It is possible that if power is lost on the windlass, it may also be lost on cargo winches. If this is the case, then manual power, together with an improvised capstan, might be considered.

Failing all else, buoy the anchor cable and slip.

ANCHOR RECOVERY — LOSS OF WINDLASS POWER

Should a vessel lose the use of cable holder or windlass in a situation with the anchor down, recovery of the anchor may prove difficult but

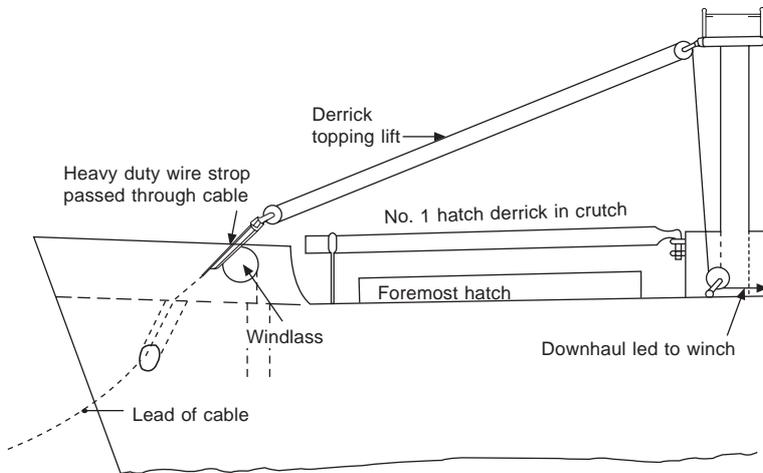


Figure 2.24 Anchor recovery after loss of windlass power.

not impossible. The method indicated in Figure 2.24 shows an alternative to rigging recovery tackle as described.

This method eliminates the use of overhauling gear and reduces the time to effect recovery. However, the system could only be employed on certain conventional vessels equipped with lifting gear forward. Figure 2.24 shows that the operation is rigged for the topping lift of the derrick to be secured to the cable above the hawse pipe, the downhaul of the topping lift then being led via lead blocks to a cargo winch.

The topping lift is secured to the cable by means of a heavy duty steel-wire strop or snorter passed through the cable links and shackled to the moving block. The windlass should be out of gear, with the cable being held on the brake. Start heaving on the topping lift and take the weight off the windlass, then release the brake. Continue to heave on the topping lift, allowing the gypsy of the windlass to freewheel, walking the cable back into the spurling pipe.

Place the brake hard on, detach the wire strop and re-secure to repeat the process for as many times as it takes to recover the full scope of cable.

HANGING OFF AN ANCHOR

There may be occasion in the ship's life to detach the anchor from the cable, either for mooring to a buoy or for towing operations, where the bare end of cable is required. The method of obtaining the bare end of cable was associated with 'catting the anchor', where a vessel was equipped with a 'clump cathead'. A modern vessel will either be able to detach the cable while leaving the anchor secured in the hawse pipe or it will become necessary to 'hang the anchor off' (Figures 2.25 and 2.26).

The operation of hanging off an anchor is generally carried out to clear the hawse pipe and allow the bare end of the remaining cable a more suitable lead. The object of the exercise is to hang the anchor off aft of the hawse pipe, preferably about the break of the fo'c'sle head, so as not to foul the cable forward.

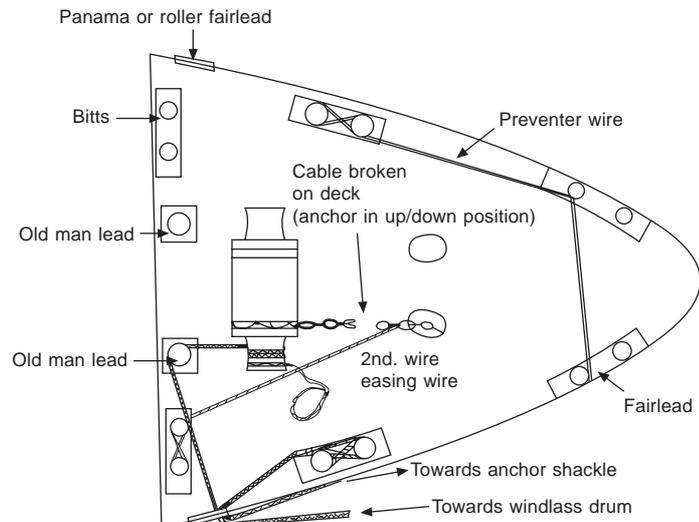
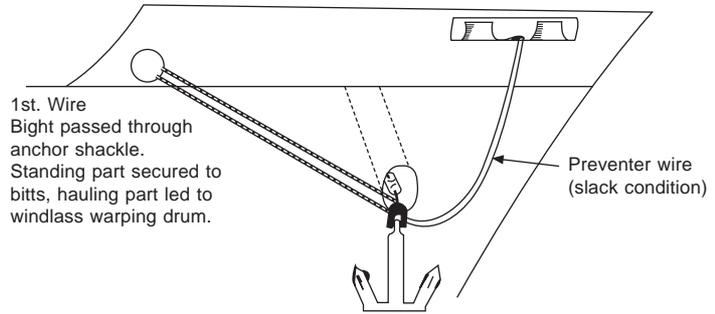


Figure 2.25 Hanging off an anchor, from shoulder position

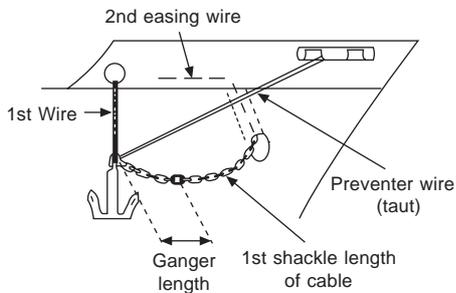


Figure 2.26 Hanging off an anchor. Once the full weight of the anchor is taken up on the first wire, the preventer should be hove taut. The easing wire should be secured forward of the next joining shackle, and the weight subsequently taken up on this. The joining shackle should now be 'broken' on deck and the bare end of the cable walked back to clear the hawse pipe. The bare end of cable is retrieved back aboard the vessel by hawser and bosun's chair operation from the fairlead, the hawse pipe being left clear to allow the use of the remaining cable inside the locker.

Sequence of Operation

1. The anchor should be walked back clear of the hawse pipe.
2. With the aid of a man in a bosun's chair, a heavy wire should be passed through the anchor crown 'D' shackle, this wire being led from the shoulder at a point from which it is intended to suspend the anchor. (The wire should be of sufficient SWL (safe working load) to accept the full weight of the anchor and a limited amount of cable.)
3. This wire should be secured aft of the fo'c'sle head, one end being turned up on bits, while the other is turned on to the windlass drum (with heavy anchors, both parts should be turned up on bits).
4. Rig a preventer wire, in a slack condition well forward of operations, in case the first wire should part once the cable is broken.
5. The anchor cable should be walked back to allow the first wire to accept full weight of the anchor. The first wire now being in the up/down position.
6. Continue to walk back on the cable to bring the next joining

shackle on deck, securing this length in short bights. Engage bow stopper or other cable-securing arrangements.

7. Rig a second easing wire forward of the joining shackle, and take the weight of the amount of cable between the anchor and the joining shackle on deck.
8. Break the joining shackle.
9. Clear away cable securings, and walk back on the easing wire to bring the bare end clear of the hawse pipe.
10. Rig a hawser, with the aid of a bosun's chair, to recover the bare end inboard via the fairlead, thus leaving the hawse pipe clear.

The cable joining shackle should not be broken until the first wire has been secured (both parts of the bight), because if control of the first wire is lost, and the cable has already been broken, then the possibility of losing anchor and a length of cable becomes more than probable. This probability is increased with very heavy anchors, e.g. 20 tonnes.

LOST ANCHOR AND RE-SECURING OF SPARE ANCHOR

Should a vessel be in the unfortunate position of having lost her port or starboard bow anchor, then she is considered to be unseaworthy for the purpose of marine insurance. It therefore becomes essential to re-secure the spare anchor as soon as is practicable.

Methods of securing the spare anchor to an end of cable will, in most cases, need considerable thought, depending on several facts:

1. Size and weight of the spare anchor.
2. Position of stowage of the spare anchor in relation to the fo'c'sle head.
3. Type of structure of the vessel, and obstructions between the spare anchor and fo'c'sle head.
4. The size and capability of lifting gear aboard the vessel, i.e. SWL of derricks/cranes etc.
5. Whether tugs are readily available.
6. Capacity of ship's own boats to transport the spare anchor from a possible after position to a forward position.
7. Whether the ship can make a port of refuge with ease and exercise a 'carry up' the quay operation, employing shore transport, e.g. a flat top truck.
8. The prevailing weather and experience of crew members, if the re-securing is to take place at sea.

A ship's spare anchor could very well be stowed right aft on a large vessel. Let us assume that the anchor is of the stockless variety and weighs approximately 12 tonnes, and that the vessel is an ore carrier with no lifting gear other than a small 3 tonne stores derrick aft. In circumstances like this the anchor could not be lifted by the normal ship's lifting gear.

However, extreme circumstances call for extreme methods. It would be feasible to employ the stores derrick winches to provide motive

power to heave the anchor from its stowage position on to a platform (wood) which would be mounted on six hydraulic jacks. The platform with the anchor could then be jacked up in the horizontal plane over and above the ship's side bulwarks.

The anchor cable would have to be walked back from the windlass and the bare end heaved back aboard over the gunwale. This bare end would then be heaved aft, by the combined operations of walking back on the windlass and heaving on the stores winch aft, while at the same time applying manual guidance to the cable as it is flaked aft. The cable must be passed outside of the vessel's obstructions for the purpose of letting go.

Clear the bare end of cable and by use of a 'D' lugged joining shackle, if one is available, re-shackle the anchor to the end link. The operation of securing the shackle will be a lengthy one. Ensure the platform accommodating the anchor is close to the ship's side; apply grease to the surface of the wood platform and check that the cable will not foul.

Manoeuvre the anchor overside by turning up the inboard jacks and lowering the outboard jacks. Personnel should be given adequate warning of the fact that the anchor is being released from the aft position.

Ideally an operation of this nature would be carried out inside the confines of a safe and sheltered harbour, probably while the vessel is in an anchored position, employing the other anchor, of course. It would therefore be a fair assumption to accept that the depth of water within the harbour would be acceptable to allow the recently secured anchor to slip from the platform clear of the vessel and be recovered in the normal manner by heaving away on the windlass.

Alternative Methods

1. When in port, or if the vessel can be expected to make a port, employ shore-side cranes to offload the spare anchor on to a flat top truck or wagon. Transport the anchor along the quayside the length of the vessel and re-secure the anchor on the quay after paying out some slack on the affected cable.
2. A large vessel carries very heavy anchors. Transport for such heavy weights must be available, e.g. 20 tonne anchor, four boats joined by a supporting platform, provided means of lifting the weight can be achieved in a safe manner to begin with.
3. Should a tug or barge be readily available for hire, considerable time and labour could be saved by engaging such a craft for the purpose of completing the operation.
4. Emergency rigs of heavy duty 'sheer legs' straddling the spare anchor could be considered, but this would depend on the weight of the anchor, not to mention the fact that materials for rigging heavy 'sheers' may not be available.
5. Another possibility would be to employ the lifting facilities of another vessel. This is a particularly attractive alternative when another vessel from the same company is close by and is in a position to moor

alongside, the lifting gear, as well as the mode of transport for the spare anchor, being provided by the second vessel.

6. The ideal craft for the operation is, of course, a floating crane, especially if the spare anchor is stowed in an awkward position, say on the after deck.
7. Should the vessel be near a drydock, the facilities of the drydock could be employed. However, it would be extremely costly to enter drydock for the one specific purpose of re-securing a spare anchor. Full consideration would have to be given to other needs, such as hull inspections, and surveys etc.

MOORING ANCHORS

Bruce (Mooring) Anchor

The Bruce anchor (Figure 2.27), probably the most up-to-date design that has reached the market for a very long time, appeared in the USA about 1975, when it won an award at the Offshore Technology Conference, held in Houston, Texas. This award was to be followed by another, from the Design Council in 1978 in the United Kingdom.

It is a self-orientating anchor; as it engages the sea bed, it rolls upright, irrespective of dropping attitude. It possesses absolute roll stability, the stabilising forces being produced by the curved shape of the flukes. It is an anchor of high holding power, and allows full veering capability, without the risk of breaking out. See also Plate 10.

The Bruce is a one-piece design anchor, with the advantage of no moving parts. It is manufactured in heat-treated cast steel, which provides added strength. It possesses a highly efficient fluke area and subsequent fluke action, together with an optimum length of shank and fluke shank

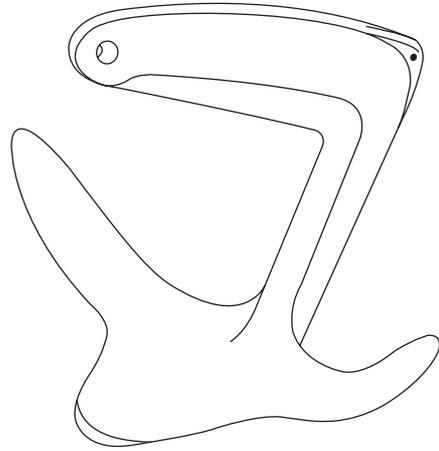
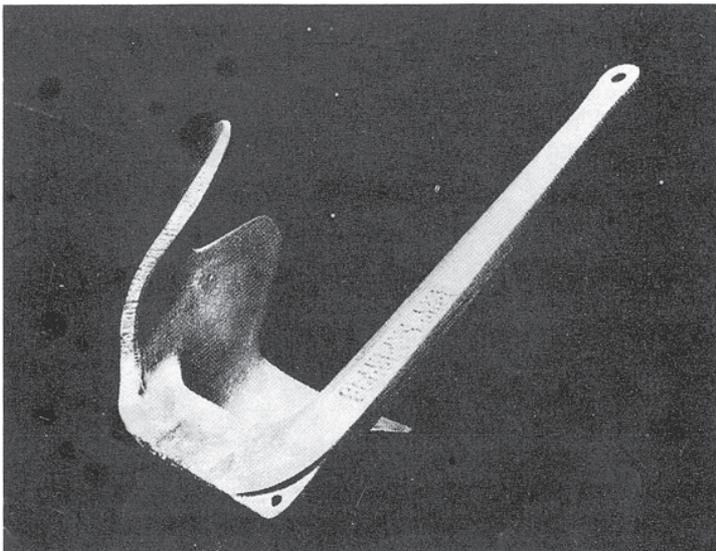


Figure 2.27 Bruce (mooring) anchor.



10. Bruce (mooring) anchor.

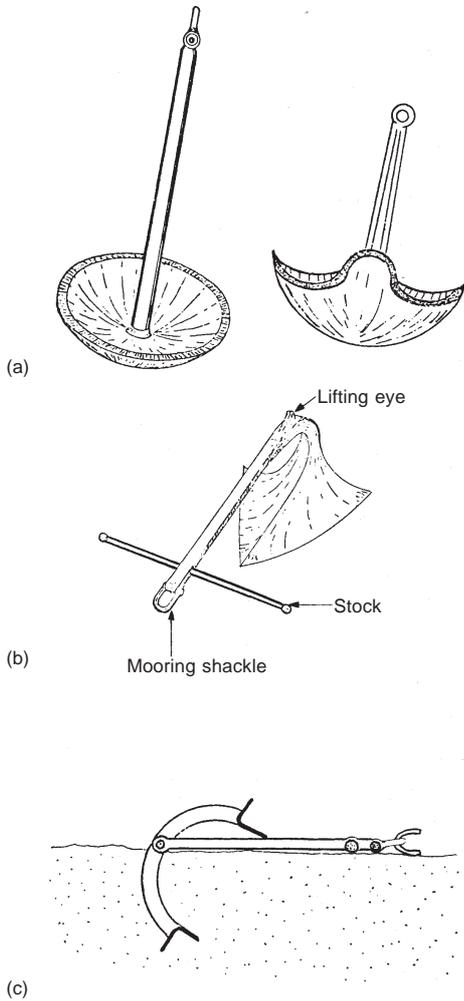


Figure 2.28 (a) Mushroom anchors; (b) improved mooring anchor; (c) Trotman mooring anchor.

separation. The flukes are curved, there being no stock, and the anchor is reasonably compact for stowing.

Bruce anchors have been manufactured up to a size of approximately 14,500 lb, which can replace conventional anchors of 45,000 lb. The need for anchors of higher holding power was generated initially by the offshore oil industry, and to date the main customers for the Bruce anchor have been from this industry. However, small-boat owners are now seeming to favour this very efficient anchor.

Once the anchor has rolled shank uppermost, any further dragging will cause it to bury. The anchor is maintained roll-stable by the stabilising forces produced by the fluke extensions. The extending fluke's insertion into the sea bed produces a higher aspect ratio than with any other anchor design. This results in very good holding power, together with higher tolerable cable angles than hitherto thought possible.

Three further mooring anchors are illustrated in Figure 2.28.

ROPEWORK



NATURAL FIBRE ROPES

All natural fibre rope is manufactured from manilla, sisal, hemp, coir, cotton or flax fibres. The process of manufacture consists of twisting the fibres into yarns and turning the yarns in an opposite direction to establish the strands. Figure 3.1 shows a hawser laid rope being laid up to form a right-hand laid rope.

Ropes may be of a right-hand lay or left-hand lay, but the most common is right-handed. It is essential to realise that each of the components is turned (twisted) up in an opposite direction to that of its predecessor, e.g. in right-hand lay, strands are laid up right-handed (clockwise), yarns laid up left-handed, and fibres laid up right-handed.

Manilla

Manilla is obtained from the abaca (wild banana) plant, which grows to about 9 m (30 ft) in height, largely in the Philippine Islands, and is exported via the port of Manila, from which it acquires its name.

Manilla rope is not as durable as hemp, but is most certainly more pliable and softer. It is gold-brown in colour, and never tarred. Unfortunately it swells when wet, but despite this it is considered by far the strongest natural rope made. It is very expensive and its availability will depend on the political climate. Used extensively where the safety of life is concerned, Grade 1 manilla is the best that you can get, but because of scarcity, and, of course, the cost to shipping companies, it is a rare feature aboard merchant vessels.

An experienced seafarer likes manilla, because it is the best. There are many so-called grades of manilla on the market, such as sisal mixed with manilla, which are not quite the same to a professional. No disrespect to these other grades of ropes, but when you need reliability with a natural fibre, this is the one to use.

Manilla is an excellent fibre for the manufacture of towing hawsers, providing good spring and stretch facilities. It is not generally used for

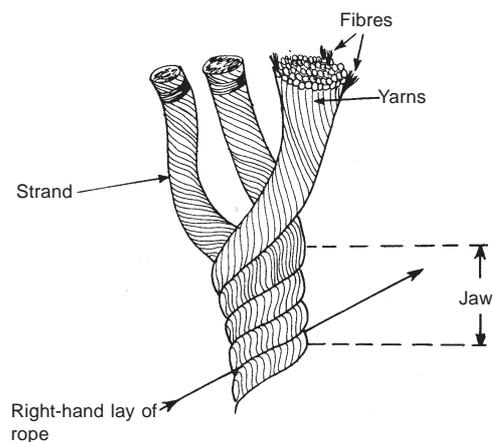


Figure 3.1 Hawser laid rope – three strands.

running rigging because it swells and expands, often jamming in the block.

Breaking strain and resistance to deterioration are listed in Tables 3.1 and 3.2.

Sisal

Obtained from the leaves of the plant *Agave Sisalana*, a large plant of the cactus family, sisal comes largely from Russia, America, East Africa, Italy, Java and countries in Central America. The plant favours a temperate or tropical climate.

The sisal rope is hairy, coarse and white. It is not as pliable as manilla nor as strong. When wet, it swells up more than manilla, as the water is absorbed more quickly, and it becomes slippery to handle.

It is extensively used in the shipping industry either in its own state or mixed with manilla fibres, a good sisal being similar in strength to a low grade manilla. The cost of production is better suited to the shipowner, and the supply is more reliable than manilla.

For handling purposes, the fibres have a brittle texture, and continued handling without gloves could cause the hands to become sore and uncomfortable. It is generally used for mooring ropes and most other general duties aboard, where risk to life is not in question. Where the rope is expected to be continually immersed in water, it may be coated

TABLE 3.1 Rope sizes for breaking strain of 86 tonnes

<i>Rope type</i>	<i>Diameter (mm)</i>	<i>Circumference (in.)</i>
Nylon	72	9
Polyester	80	10
Polypropylene	88	11
Manilla (grade 1)	112	14
Wire (6 × 24)	48	6

TABLE 3.2 Resistance of ropes to corrosion

<i>Substance</i>	<i>Resistance</i>			
	<i>Manilla or sisal</i>	<i>Nylon</i>	<i>Polyester</i>	<i>Polypropylene</i>
Sulphuric (battery) acid	None	Poor	Good	V. Good
Hydrochloric acid	None	Poor	Good	V. Good
Typical rust remover	Poor	Fair	Good	V. Good
Caustic soda	None	Good	Fair	V. Good
Liquid bleach	None	Good	V. Good	V. Good
Creosote, crude oil	Fair	None	Good	V. Good
Phenols, crude tar	Good	Fair	Good	Good
Diesel oil	Good	Good	Good	Good
Synthetic detergents	Poor	Good	Good	Good
Paint removers, varnish,				
Solvents (chlorinated)	Poor	Fair	Good	Poor
Solvents (organic)	Good	Good	Good	Good

with a water repellent. This is a chemical coating, usually tar based, which prevents rotting and mildew. Resistance to deterioration is listed in Table 3.2.

Coir

Sometimes referred to as grass line, coir is obtained from the fibres of coconut husks. It is mainly exported from Sri Lanka (formerly Ceylon) and ports in India.

It is a very rough, coarse and hairy rope, with only about one quarter the strength of a hemp rope. However, it is very light and floats, possessing great elasticity. It is often used as a towing warp or mooring spring, because of its buoyant and elastic properties.

The coir fibres are short, brittle and thick. These features produce a stiff non-flexible rope, difficult to manage. Consequently they are not popular with seafarers. When used for mooring purposes, they often have a steel wire pennant attached, and the whole is known as a coir spring. These are regularly encountered where heavy swells are common, often being run from the shore, as a permanent mooring picked up by the ship on berthing.

This rope is never tarred, as this would weaken the fibres considerably. If the rope becomes wet when in use, it should be dried before being stowed away. The coir fibres are found aboard many vessels in the form of coir door mats.

Hemp

Hemp is obtained from the stem of the plant *cannabis sativa*, which yields flax for the production of canvas. (The word canvas is derived from the Latin '*cannabis*', which means hemp.) This was accepted as the best rope in the marine industry from the early developing days of sail. *Cannabis sativa* is cultivated in many parts of the world – New Zealand, Russia, China, India, and the USA, for instance – but has been replaced mainly by man-made fibre ropes and manilla.

The hemp fibres are a light cream in colour when supplied to the rope manufacturer. They have a silky texture and are of a very fine nature: hence the extra flexibility of the hemp rope compared to a sisal or manilla.

Most hemp ropes treated in manufacture produce a tarred, brown rope which is hard and hairy to the touch. Its strength will be dependent on the place of production. Italian hemp ropes are now considered to be the best quality, having about 20 per cent greater strength than a high grade manilla. However, quality differs considerably, and hemp ropes are rarely seen at sea today except in the form of small stuff, e.g. lead line – cable laid hemp, sea anchor hawsers, bolt rope etc.

The advantage of hemp rope is that it is impervious to water and does not shrink or swell when wet. For this reason it was extensively used for the rigging of sailing vessels, and roping sails. When used for running rigging, it was preferred to manilla or sisal because it did not swell up and foul the blocks. However, for vessels navigating in cold climates,

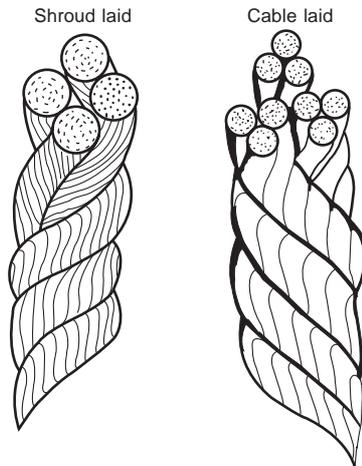


Figure 3.2 Types of rope lay.

hemp ropes do have a tendency to freeze up. Not all hemp ropes are supplied tarred, so that the weight will vary, together with the strength.

LAY OF ROPE

The lay of rope is a term used to describe the nature of the twist that produces the complete rope, as we have already explained (p. 59). The purpose of alternate twisting of fibres, yarns and strands is to prevent the rope becoming unlaid when in use.

The majority of ropes are manufactured with a right-hand lay, but left-hand laid ropes are available. The most common form of rope at sea is known as 'hawser laid rope' comprising three strands laid up right- or left-handed. Other types of lay include 'cable lay' (Figure 3.2), made of three or four hawsers laid up left-handed, and sometimes referred to as water lay, which is strictly incorrect. 'Water lay' was a rope designed to be used when wet, e.g. sounding line. Consequently it was laid up in the course of manufacture in a wet condition, so allowing for shrinkage in use. Cable-laid ropes, although generally left-handed lay, may be encountered as right-hand lay (left-hand hawsers being used) but these are extremely rare.

Eight Strand Plaited

Many mooring ropes used at sea today are 'eight strand plaited', constructed by laying two pairs of strands left-handed, with the other two pairs right-handed. This type of lay has the advantages that it does not kink and also, with eight strands, has increased flexibility. However, it is difficult to splice, and the manufacturers' instructions should be consulted.

Shroud Lay

Another type of lay found at sea is 'shroud lay' (Figure 3.2), consisting of four strands, sometimes being laid about a central heart, right-handed. As the name implies, it was used for standing rigging (the shrouds to the mast) until wire ropes came into use.

Soft-Laid

Often referred to as a long lay, soft-laid is a strong flexible method of laying up a rope. The angle of the strand to the axis through the centre of the rope is comparatively small. It will absorb water more easily and will not be as hard-wearing for example as a hard-laid rope. The 'jaw' of the lay is large with a soft-laid rope.

Hard-Laid

Sometimes called short lay, when the 'jaw' of the lay is small in comparison to a soft-laid rope, hard-laid is harder wearing than the former, does not easily absorb water and tends to retain its shape better when under stress. Being hard in construction, it is not very flexible, and its breaking stress and subsequent safe working load are inferior to those of soft or standard laid ropes.

Standard or Plain Laid

Standard lay may be described as a cross between hard- and soft-laid ropes. It has been found by experience to be the best in providing pliability and strength, and to be sufficiently hard-wearing and chafe-resistant to suit the industry for general purpose working.

Sennet-Laid

Alternatively known as plaited, but not as in the way as the 'eight strand plaited' previously mentioned, an example of sennet lay is found with the patent log line, where the yarns are interwoven, often about a centre heart. This lay of rope has an effective anti-twist, non-rotational property.

Unkinkable Lay

This lay looks like standard lay, but close inspection will reveal that the yarns are twisted the same way as the strands. Left-handed in construction, it is usually ordered for a specific job, e.g. gangway falls. The advantage of this lay is that the tendency for standard lay to kink when passing through a block is eliminated.

SMALL STUFF

Small stuff is a collective term used at sea with respect to small cordage usually less than $1\frac{1}{2}$ in. in circumference and of 12 mm diameter approximately.

Hambroline (hamber line)

Also known as codline, this is supplied in hanks of about 30 fathoms. It is made of soft tarred hemp, three yarn or three-stranded, laid up right-handed. It is manufactured in two sizes, three or six threads, and is used for lashings where strength is essential, or for lacing sails usually an untarred variety having a hard lay.

Houseline

Manufactured from Indian hemp, houseline is made of three yarns laid up left-handed. It is tarred and sold in balls by weight and often used to secure bolt rope to sails.

Boat Lacing

Manufactured in fourteen various sizes, it is made of a high grade dressed hemp, having a fine finish and being smooth to handle. Before the invention of man-made fibre, it was used for securing boat covers, awnings etc. It is sold in hanks weighing from 93 g to 1.8 kg.

Marline

Marline is usually supplied in hanks by weight, tarred or untarred. It is made in two ply, i.e. two yarns laid up left-handed, from better quality

fibres than spunyarn, and produces a much neater, tighter finish to any job. It is used for seizings, serving and whipping heavy duty ropes.

Spunyarn

Made from any cheap fibres and turned into yarns, spunyarn may have two, three or four yarns, usually laid up left-handed. The yarns are supposed to be soaked in Stockholm tar, for spunyarn is used for the serving of wires, and the idea was that in hot climates the lubricant (Stockholm tar) would not run from the serving. Spunyarn is generally sold in balls of up to 3.2 kg or in coils of 6.4 kg or 25.6 kg by length or weight.

Point Line

A three-stranded manilla rope, point line is made and may be ordered in three sizes, which are determined by the number of threads:

Circumference $1\frac{3}{8}$ in diameter 11 mm 15 threads.

Circumference $1\frac{1}{2}$ in diameter 12 mm 18 threads.

Circumference $1\frac{5}{8}$ in diameter 13 mm 21 threads.

It is used as an all-purpose lashing aboard most present vessels. Sisal very often replaces manilla in so-called point line.

Ratline

This is one of the family of tarred cordage, measured the same as point line, except that the number of threads may be as high as twenty-four (circ. $1\frac{3}{4}$ in.). It was used in the past for steps between the shrouds of a mast. If seen on a modern vessel, it will probably be encountered as a heaving line. Supplied in coils of 120 fathoms, it is made of three-stranded soft hemp, hawser lay.

Logline

Logline is made of sennet-laid hemp (plaited), specially for the towing of the rotator (patent log), and comes in 40, 50, 65, or 70 fathom coils. The size will vary from about $\frac{3}{4}$ in. to $1\frac{1}{2}$ in. (6–12 mm diameter). The woven line is kink proof, very durable and sometimes built up about a copper wire core.

Lead Line

Made of high grade cable-laid hemp, it may be obtained in two sizes: $1\frac{1}{8}$ in. (9 mm diameter) for hand lead lines, and $1\frac{1}{2}$ in. (12 mm diameter) for deep sea lead lines. It is supplied in 30 fathom coils for the hand lead, and in 120 fathom coils for the deep sea lead.

Seaming Twine

Manufactured from the best flax, this three-ply twine is made up in hanks of approximately 1 lb weight and 900 fathoms length. It is used extensively for canvas work.

Roping Twine

This five-ply twine is supplied in hanks of similar length and weight to that of seaming twine. It is used for whipping the ends of ropes, worming etc.

Signal Halyard

Often spelt halliard, this used to be three- or four-stranded dressed hemp, but this natural fibre has given way to man-made fibres such as polypropylene. It may be supplied in a variety of sizes to the customer's requirements. Plaited laid halliards are predominant on the modern merchant vessel, being preferred because the stretch is not as great as, say, hawser lay. The word halyard was derived from the old-fashioned 'haul yard', which was previously employed on sailing vessels to trim and set the sails to the yard arms.

Many natural fibre products such as 'Ratline' and 'Hambroline' have been phased out of common use with modern ship designs and have been superseded by man-made fibre substitutes.

SYNTHETIC FIBRE ROPES

Although natural fibre ropes are still widely used throughout the marine industry, they have been superseded by synthetic fibres for a great many purposes. Not only do the majority of synthetic ropes have greater strength than their natural fibre counterparts, but they are more easily obtainable and at present considerably cheaper.

Breaking strain and resistance to deterioration are listed in Tables 3.1 and 3.2.

Nylon

This is the strongest of all the man-made fibre ropes. It has good elasticity, stretching up to 30 per cent and returning to its original length. It is used for such functions as shock-absorbing when coupled with a mooring wire: the nylon forms a rope tail which takes the heavy shocks as a vessel ranges on her moorings. It is also used in a combination tow line – one section steel wire and one section nylon rope.

Nylon ropes are light to handle, twice as strong as an equivalent sized manilla and give the appearance of a smooth slippery surface. They are impervious to water, have a high melting point, 250°C, and in normal temperature are pliable, being suitable for most forms of rigging.

The disadvantages of nylon ropes are that they do not float, and in cold climates they tend to stiffen up and become difficult to handle. They should not be left exposed to strong sunlight or be stowed on hot deck surfaces, as their natural life will be impaired. The significant point with these ropes is that they are used when great stress occurs. Should they part under such stress, there is a tendency for them to act like elastic bands, an extremely dangerous condition to be allowed to develop. The nylon rope will give no audible warning when about to part; however, when under excessive stress, the size of the rope will considerably reduce. They are difficult to render on a set of bits, and should never be allowed to surge. Any splices in the nylon ropes will tend to draw more easily than in natural fibre when under stress. Nylon is expensive, but its life may be considered to be five times as long as its manilla equivalent.

Polyester

A heavy rope compared to the nylon and not as strong, but nevertheless some of the polyester's properties make it a worthwhile rope to have aboard. It is considered to be more resistant to acids, oils and organic solvents than its nylon counterpart, while its strength remains the same whether in a dry or wet condition. It is used for mooring tails and mooring ropes.

Its disadvantages are very similar to nylon's. It will not float. Splices must have four full tucks and may draw more easily than with a natural fibre rope when under stress. It should not be surged on drum ends. Frictional heat should be kept to a minimum when working about bits or warping drums. The melting point is between 230° and 250°C.

Polypropylene

This is probably the most popular of the man-made fibres at sea. The ropes are cheap, light to handle, have the same strength whether wet or dry, and they float. They are used extensively for mooring ropes and running rigging. The melting point is low compared to nylon, 165°C. Friction-generated heat should be avoided with this man-made fibre, which is extremely susceptible to melting and fusing. Should the fibres fuse together, the rope is permanently damaged and weakened.

It is resistant to chemical attack by acids, alkalis and oils, but solvents and bleaching agents may cause deterioration. It neither absorbs nor retains water, and because of this fact has recently been used for the inner core of wire ropes, the advantage being that inner corrosion in the wire is eliminated. However, the wire would still need to be lubricated externally.

Fibrefilm, a by-product from polypropylene, is a very cheap version of the fibre. It is produced from continuous thin twisted polypropylene tape, and used for general lashing purposes.

Precautions When Handling Synthetic Man-Made Fibre Ropes

- 1 The mariner should carefully inspect a rope, both internally and externally, before it is used. Man-made fibre ropes show deterioration after excessive wear by a high degree of powdering between the strands.
- 2 Ropes should be kept out of direct sunlight. When not in use, they should be covered by canvas or other shield, or, if the vessel is engaged on long sea passages, stowed away.
- 3 When putting a splice in a synthetic fibre rope, use four full tucks, followed by two tapered tucks (strands halved and quartered). The length of the protruding tails from the completed splice should be left at least three rope diameters in length. Any tail ends of strands should be sealed by tape or similar adhesives.
- 4 A stopper should be of the same material as that of the rope being stoppered off, and should preferably be of the 'West Country' type. The one notable exception to this rule is that a nylon stopper should never be applied to a nylon (polyamide) rope.

5. A minimum number of turns should be used when heaving man-made fibre ropes about winch barrels or capstans. Friction-generated heat should be avoided, and to this end no more than three turns should be used on drums. Where whelped drums are being used, it may be necessary to increase the number of turns so as to allow the rope to grip; if this is the case, then these turns should be removed as soon as possible.
6. Never surge on man-made fibre rope. Should it be required to ease the weight off the rope, walk back the barrel or drum end, as when coming back to a stopper.
7. When making fast to bitts, make two round turns about the leading post, or two turns about both posts, before figure-eighting (see Figure 3.3).

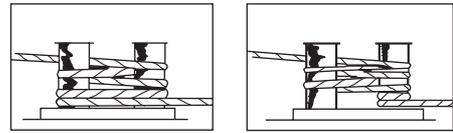


Figure 3.3 Making fast to bitts.

BENDS AND HITCHES

Blackwall Hitch – Single

Used as a jamming hitch, this is not in common use at sea today, since it was found unreliable and had a tendency to slip. It is only effective on the larger style of hook with a wide surface area or on the very small jaw hooks (see Figure 3.4).

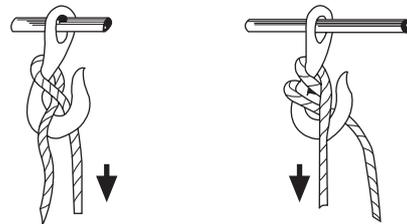


Figure 3.4 Single Blackwall hitch (left) and double (right).

Blackwall Hitch – Double

This is used for the same reasons as above but with far more confidence. Holding power is considerably better than that of a single Blackwall, and light hoists could be made with this hitch (see Figure 3.4).

Bowline

Probably the most common of all hitches in use at sea is the bowline (Figure 3.5). If is by far the best way of making a temporary eye in the end of a rope, whether it be point line or mooring rope size. It will not slip even when wet, it will not jam, and it will come adrift easily when no longer required. It is commonly used to secure a heaving line to the eye of a mooring rope when running a line ashore.

Bowline on the Bight

This is one of several variants of the bowline, made with the bight of the rope, so forming two eyes (Figure 3.5). One of these eyes should be made larger than the other to accommodate the seat, while the smaller of the two eyes would take the weight under the arms of an injured person. It forms a temporary bosun's chair for lifting or lowering an injured person. It may be necessary to protect the person from rope burn or pressure by padding under the seat and armpits.

Bowline – Running

A slip knot is made by dipping the bight of rope around the standing

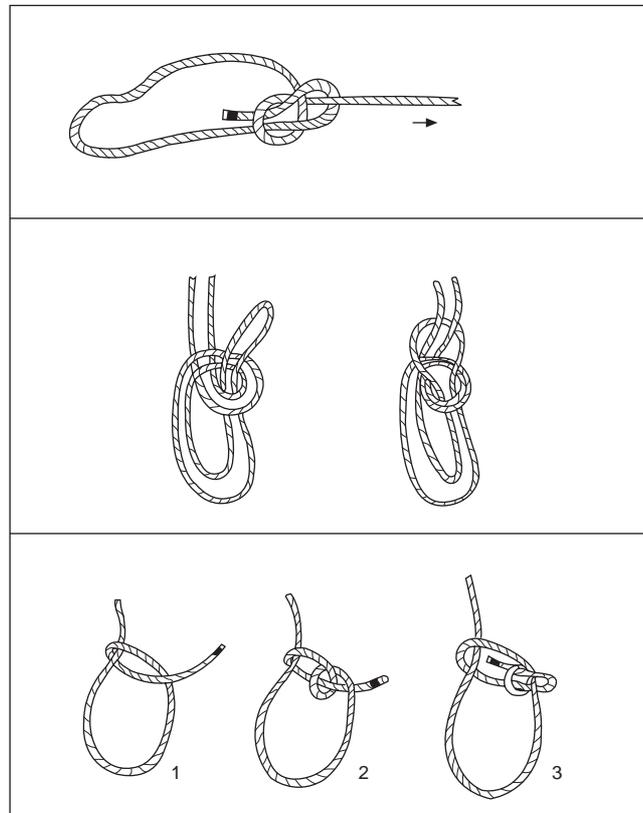


Figure 3.5 Bowline (top), bowline on the bight (middle) and running bowline (bottom).

part and securing an ordinary bowline on to its own part, so forming a running noose (Figure 3.5). It should be noted that it is a common mistake for inexperienced seafarers to assume that the tail end of rope can be passed through the eye of an ordinary bowline. This is not only inaccurate but time-consuming, especially if the length of the rope is considerable, as with a full coil.

Bowline – French

An alternative to the bowline on the bight, this hitch has the same function of allowing the weight of a man to be taken up by the two eyes (see Figure 3.6).

Carrick Bend – Single

Originally used for bending two hawsers around a capstan, the bend was constructed so that it formed a round knot which it was thought would not become jammed in the whelps of the capstan barrel. It is a strong versatile bend that will not jam under strain, providing it is properly secured (Figure 3.7).

The idea of the knot is for the weight to be taken on either side; the bend should be seen to hold, and only then should the tail ends be seized to the standing parts. It is often thought that the ends should be seized

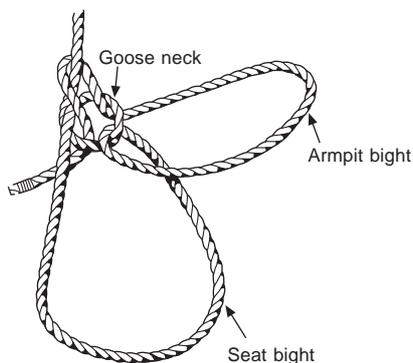


Figure 3.6 French bowline.

immediately after securing the bend, but this is not the case; weight must first be taken and the bend will be seen to slip and close up on itself; only after this has occurred should the ends be seized.

Carrick Bend – Double

This version of the carrick bend (Figure 3.7) is formed in a similar manner, except that a round turn is made about the cross of the first hawser. It is used where additional weight could be expected to bear, as in towing operations.

Again the tails should be left sufficiently long so that, when the weight is taken up and the bend slips to close itself, there will be enough slack in the two tails left to seize down to the standing part. The advantage of this bend over a sheetbend is that it will easily come adrift when no longer required, whereas the sheetbend may jam and have to be cut away.

Carrick Bend – (Single) Diamond

So called because of the diamond shape formed in the middle of the bend, prior to taking weight on the two hawsers either side, it only differs from the single carrick in the fact that the tail end is not seized on the same side as in the single carrick, thus giving the appearance of being a different version of the single carrick. It is used for exactly the same purposes as above, and forms the basis for many fancy ropework knots (see Figure 3.7).

'Catspaw'

This is used to shorten a bale sling strop and is constructed by using two bights of the strop. Two eyes are formed by simply twisting each bight against itself, the same number of twist turns being applied to each bight. The two eyes so formed can then be secured to a lifting hook or joined by a securing shackle (see Figure 3.8).

The stevedore's method of 'shortening a strop' (Figure 3.9) is an alternative to the 'catspaw'. It is achieved by passing opposing bights of the strop through their own parts, effectively making an overhand knot with the bights.

Clove Hitch

A very common hitch in use at sea today, it consists of two half hitches jamming against each other. It is a useful knot for turning about a rail and hanging things from, but unreliable, especially when the direction of weight is liable to change; that could easily cause it to slip (see Figure 3.8).

Cow Hitch

This hitch is used to form the 'bale hitch' when employing a bale sling strop. It is, however, more commonly used to hold a wire rope when constructing a chain stopper (see Figure 3.8).

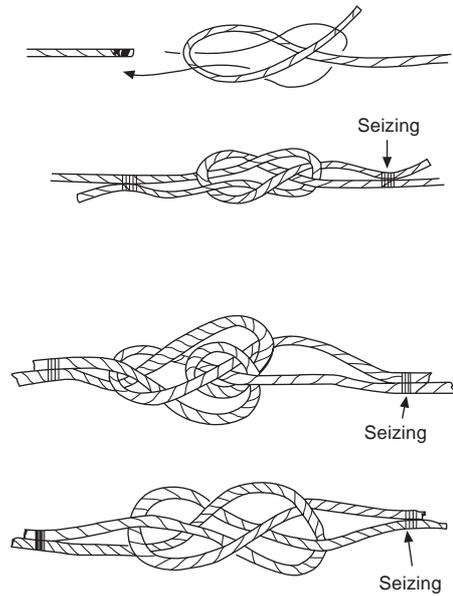


Figure 3.7 Carrick bends: single (top), double (middle) and diamond (bottom).

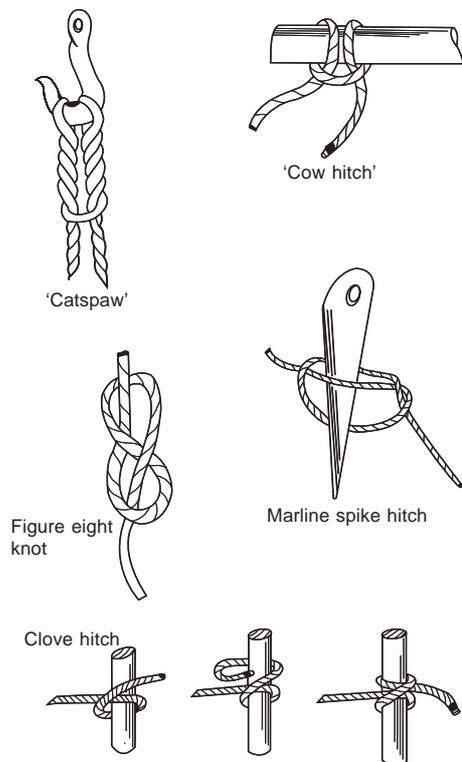


Figure 3.8

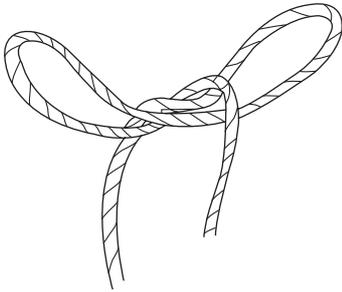
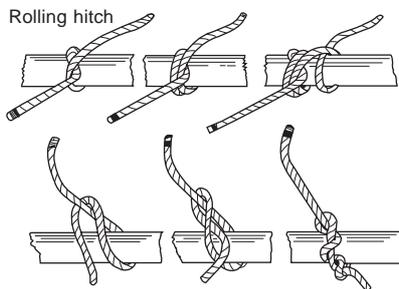


Figure 3.9 Stevedore's method of 'shortening a strop'.



Timber hitch

Figure 3.10 Rolling hitch (above), timber hitch (below).

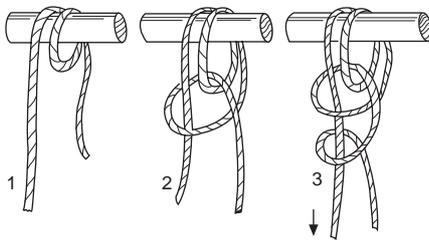


Figure 3.11 Fisherman's bend.

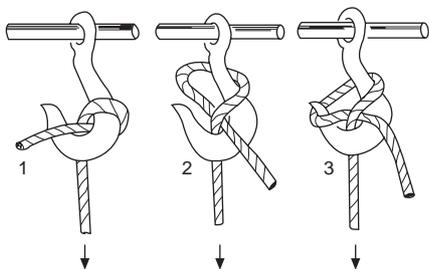


Figure 3.12 Midshipman's hitch.

Figure Eight Knot

Used as a stopper knot and employed in many forms, especially at sea, it can regularly be found in the lifelines of ships' lifeboats and in the keel grablines of boats' rigging. It is also used to secure the logline to the frog and patent rotator. An all-purpose knot, it prevents a rope from running through a block (see Figure 3.8).

Fisherman's Bend

This is used for securing a hawser to the ring of a buoy. The bend differs from the round turn and two half hitches, for the first half hitch is passed through the round turn. The second half hitch is not always applied, but, in any event, with both the round turn and two half hitches and the fisherman's bend, the tail end of the securing should always be seized down to the standing part (see Figure 3.11).

Marline Spike Hitch

An easily constructed hitch (Figure 3.8) much used by riggers to gain more leverage when gripping thin line or rope. It is useful when whipping or binding is required to be drawn exceptional tight.

Midshipman's Hitch

This hitch may be used instead of a Blackwall hitch, especially when the rope being used is 'greasy'. It is a quick method of securing a rope's length to a hook (see Figure 3.12).

Reef Knot

This is basically a flat knot, ideal for securing bandages over a wound when tending injured personnel; the flat knot lies comfortably against the patient without aggravation. It is also employed in boat work, for the purpose of reefing sails (see Figure 3.13).

Rolling Hitch

The rolling hitch is one of the most useful hitches employed at sea (Figure 3.10). Providing it is properly secured and the weight is against the double bight turn, the hitch should not slip. As it is a secure hitch, it is used to secure the jib halyard block to the sea anchor hawser, when rigging a whip for use with the oil bag from a lifeboat.

Old sailors used to secure their hammocks by use of a rolling hitch. This prevented the hammock from sliding to and fro with the motion of the vessel when in a seaway.

Round Turn and Two Half Hitches

This all-purpose hitch is used to secure a rope or hawser to a ring or spar, e.g. to secure the tail block of a breeches buoy rig. It is useful in the fact that by removing the two half hitches, the weight on the rope can still be retained and eased out by slipping the round turn. An example of this

in action is seen when ‘bowsing in’ tackles are employed in launching ships’ lifeboats (see Figure 3.14).

Sheepshank

The sheepshank (Figure 3.15) is used generally for shortening a rope without cutting its length. It is often used in keel grablines under ships’ lifeboats, and may also be employed to adjust the length of a boat’s painter when the boat is tied alongside in tidal waters, as the tide rises or falls.

Sheetbend – Single

This hitch is commonly used (Figure 3.16) to join two ropes of unequal thickness. However, when employed for this purpose, there is a tendency for it to ‘jam up’ after weight has been taken on the standing part. A carrick bend would be more suitable when weight, such as that consequent upon a towing operation, is expected.

Sheetbend – Double

This is used extensively when security over and above that which could be expected when employing a single sheetbend is required. It is used whenever human life needs safeguarding, for example when securing a bosun’s chair to a gantline (see Figure 3.16).

Timber Hitch

A slip knot, in common use at sea today, the timber hitch (Figure 3.10) lends itself to gripping a smooth surface like a spar or log. It is often used in conjunction with a half hitch. It may also be used for lifting light cases or bales, but the mariner should be aware that it is a slip knot, and once the weight comes off it, there would be a tendency for the hitch to loose itself.

Barrel Slings

See Figures 3.17 and 3.18.

WORKING ALOFT AND OVERSIDE

Rigging the Bosun’s Chair

See Figure 3.19. Close inspection should be made of the chair itself and the gantline before the chair is used. The gantline should be seen to be in good condition, and if any doubt exists, a new rope should be broken out. The bridle to the chair should be inspected, and particular attention paid to the internal lay and its condition. A safety line with safety harness must always be worn when operating from a bosun’s chair. This line should also be inspected before use, then secured to a separate anchor point. When working from a bosun’s chair, the following precautions should be observed:

1. Always secure the gantline to the chair with a double sheet bend.
2. Always have the chair hoisted manually, and never heave away on the down haul using a winch drum end.



Figure 3.13 Reef knot.

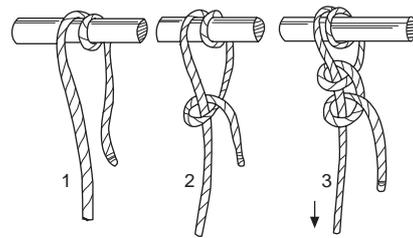


Figure 3.14 Round turn and two half hitches.

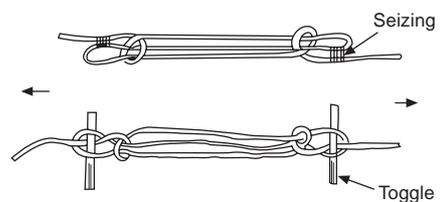
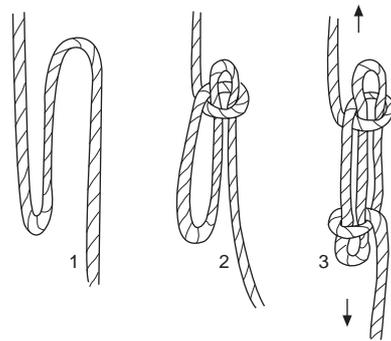


Figure 3.15 Sheepshank (above) and securing the sheepshank (below).

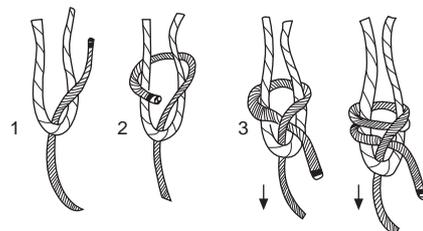


Figure 3.16 Single and double sheetbends.

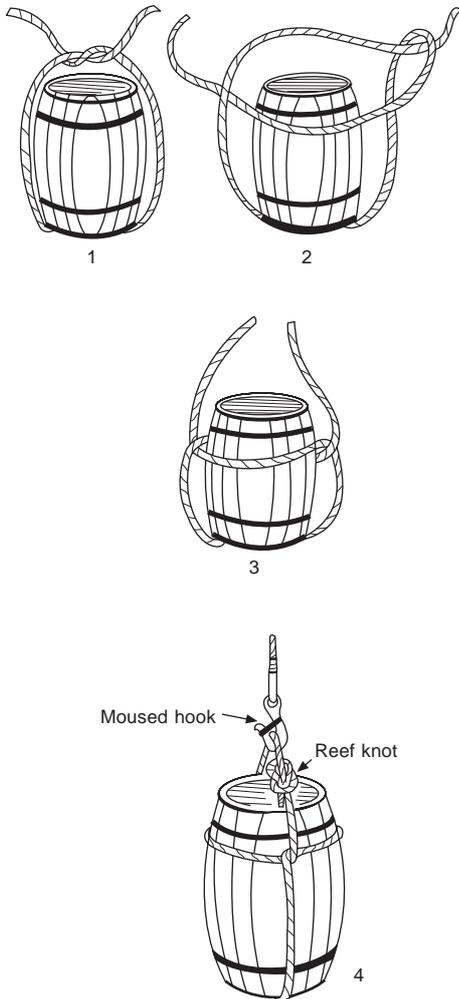


Figure 3.17 Single barrel sling.

1. Pass bight under the cask and secure with an overhand knot above the open end of the cask.
2. Open up the overhand knot.
3. Take the weight on either side of the cask.
4. Secure both tails with a reef knot. Ensure that the reef knot is secured low to the top end of the cask, to allow the full weight to be taken on the standing part.

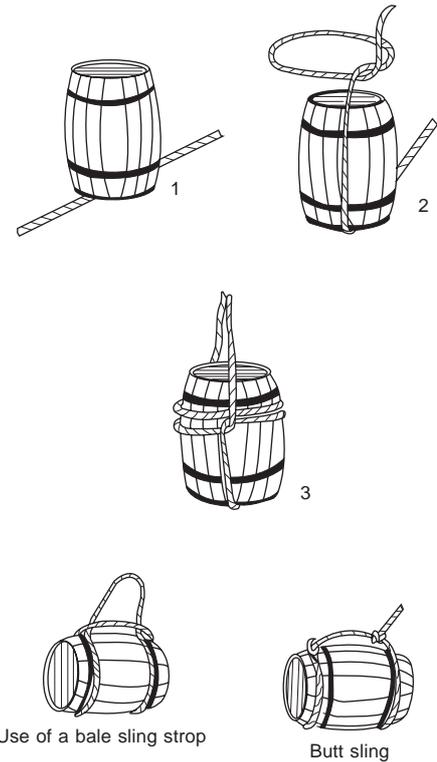


Figure 3.18 Double barrel sling.

1. Pass the bight under the cask.
 2. Pass open half hitch over the cask with each tail.
 3. Tension each tail and secure with reef knot as for single barrel hitch.
- (Below) Slings a cask on its side.

3. Any tools, paint pots etc. should be secured by lanyards. Any loose articles should be removed to prevent falling when aloft.
4. When riding a stay, make sure the bolt of the bow shackle passes through the becket of the bridle. This bolt should be moused.
5. Should work be required about the funnels, aerials, radar scanners and the like, the appropriate authority should be informed – engine room, radio officer or Bridge respectively.

The lowering hitch is normal when the chair is to be used for a vertical lift. The man using the chair should make his own lowering hitch, and care should be taken that both parts of the gantline are frapped together to secure the chair before making the lowering hitch.

Whether making a vertical lift or when riding a stay, ensure the tail block or lizard, whichever is being used, is weight tested, to check that it is properly secured and will take the required weight.

Rigging Stages

Before rigging stages (Figure 3.20), take certain precautions:

1. Check that the stage is clean and free from grease, that the wood is not rotten, and that the structure is sound in every way.
2. Check that the gantlines to be used are clean and new. If in any doubt, break out a new coil of rope. Conditions of used cordage may be checked by opening up the lay to inspect the rope on the inside.
3. The stage should be load-tested to four times the intended load (as per Code of Safe Working Practice).
4. Stages should not be rigged over a dock or hard surface, only over water. Many vessels are designed with working surfaces for painting such areas as Bridge fronts. Other vessels will be equipped with scaffolding for such jobs.
5. Lizards must be in good condition and well secured.
6. Stages should not be rigged upside for working when the vessel is under way.
7. The gantlines should be of adequate length, and rigged clear of sharp edges, which could cause a bad nip in the rope.
8. A correct stage hitch, together with lowering turns, must be applied.

The stage hitch should be made by the seaman going on to the stage. It is made about the end and the horns of the stage. For additional safety two alternate half hitches should be made about the horns before tying off the bowline. This bowline to be secured about 1½–2 m above the stage itself to provide the stage with stability.

The lowering turns must be seen to be running on opposite sides of the stage to prevent the stage from tilting. Safety line and harness for each man should be secured to a separate point, and these must be tended by a standby man on deck. A side ladder, together with a lifebuoy, should be on site. All tools etc. should be on lanyards, and the gantlines extended down to the water.

SEIZINGS

Flat Seizing

Make a small eye in the end of the seizing small stuff, pass the formed nose about the two ropes to be seized, then continue with about six loose turns about the two ropes. Pass the tail through the inside of the

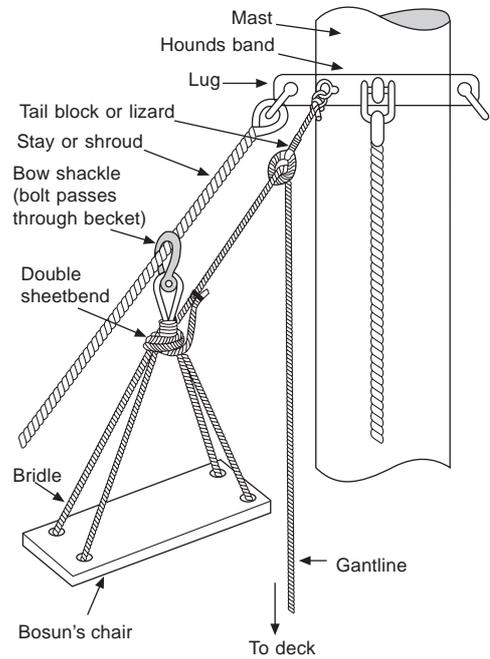


Figure 3.19 Rigging a bosun's chair for riding a stay. Bolt of bow shackle must be moused and crown bow must pass over the stay.

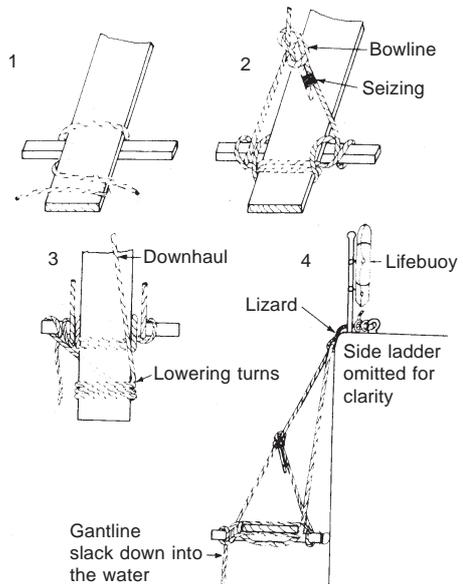


Figure 3.20 Rigging the stage.

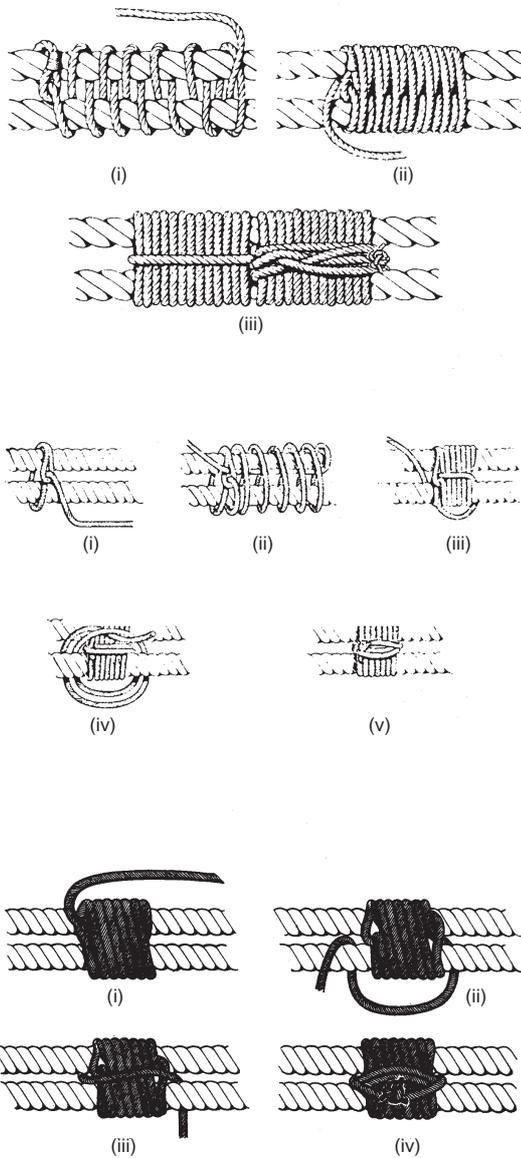


Figure 3.21 Seizings: racking (top), flat (middle) and round (bottom).

loose turns and pull the seizing taut. Pass frapping turns in the form of a clove hitch about the seizing between the two parts of rope. The seizing so formed is a single row of turns, and is used when the stresses on the two parts of the ropes are equal (see Figure 3.21).

Racking Seizing

Use spunyarn or other small stuff of suitable strength and size, with an eye in one end. Pass the seizing about the two ropes, threading the end through the ready-made eye. Use figure of eight turns between the two ropes for up to ten or twelve turns, then pass riding turns over the whole between the figure of eight turns.

Once the riding turns are completed, the seizing should be finished by passing frapping turns between the two ropes, and securing with a clove hitch. This seizing is very strong, and should be used when the stresses in the two ropes to be seized are of an unequal force (see Figure 3.21).

Rose Seizing

This is a means of securing an eye of a rope to a spar or other similar surface. The seizing is rove as a crossed lashing between the parts of the eye and under the spar, the whole being finished off by the end being half-hitched about the seizing under the eye.

Round Seizing

This is a stronger seizing (Figure 3.21) than the flat, and is used when the stresses on the two ropes are equal but extra weight may be brought to bear on the formed seizing. It is started in a similar manner to the other two, with an eye in the end of the small stuff. Begin as for a flat seizing and obtain a single row of turns. Work back over these turns with a complete row of riding turns. Pass frapping turns around the whole double row of turns between the two parts of the rope, finishing with a clove hitch.

ROPEWORK AND CORDAGE TOOLS

Hand Fid

A hand fid is a tapered piece of hard wood, usually lignum vitae, round in section, used to open up the lay of a rope when putting in a splice. The wood has a highly polished finish for the purpose of slipping in between the strands of the rope. The hand fid is always made of wood, not steel, so as not to cut the fibres of the rope. (It is not to be confused with the fid supporting the telescopic topmast.)

Riggers' (Sweden) Fid

This is a hand fid, constructed with a wooden handle attached to a U-shaped taper of stainless steel. A more modern implement than the wooden hand fid, it is suitable for ropes or wires. The U-shaped groove

down the side permits the passage of the strands when splicing. The end being rounded off so as not to cut the yarns of the ropes, and the metal has a thick smooth nature, with a blunt edge, for the same reason.

Serving Board

This is a flat board, fitted with a handle for the purpose of serving the wire eye splice. The underside of the board has a similar groove to that of the serving mallet, except that the groove is 'flatter' and more open, to accommodate the broad eye of the wire rope where it has been spliced.

Serving Mallet

This wooden mallet, cut with a deep-set groove running the full length of the hammer head, is used to turn the serving (marline or spunyarn) about the wire rope. The groove accommodates the wire as the implement acts as a lever to make the serving very tight (see worming, parcelling and serving below).

Setting Fid

This may be described as a giant version of the hand fid. It is used for splicing larger types of rope, e.g. mooring ropes, often in conjunction with a mallet to drive the taper of the fid through the strands of the rope.

WORMING, PARCELLING AND SERVING AID TO MEMORY
WORM AND PARCEL WITH THE LAY,
TURN AND SERVE THE OTHER WAY

The purpose of the operation of worming, parcelling and serving (Figure 3.22) is three-fold. First, the covering will preserve and protect the wire from deterioration (mainly due to bad weather). Second, the covering will also protect the mariner from 'jags' in the wire, when handling. Third, the completed operation will produce a neat tidy finish. Seafarers generally take a pride in a clean and tidy ship, so it does help the morale of the vessel.

Worming

In this first part of the operation a 'filler' of suitable small stuff is wove around the wire, in between the strands. This effectively prepares the way for the parcelling to produce a smooth finish, prior to serving. Marline should not be used for the worming because it is too hard and will not easily compress. When parcelled over it may cause the surface to be uneven. Small stuff suitable for the purpose of worming includes spunyarn, hemp yarns, or small rope, depending on the size of the wire being worked. The worming should be carried out in the direction of the lay of the wire.

Parcelling

This is the covering of the wire and the worming by oiled sacking, burlap, or tarred canvas. The material is cut into strips up to 3 in.

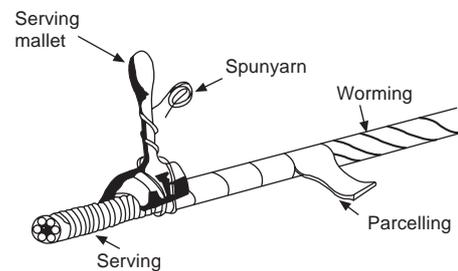


Figure 3.22 Worming, parcelling and serving.

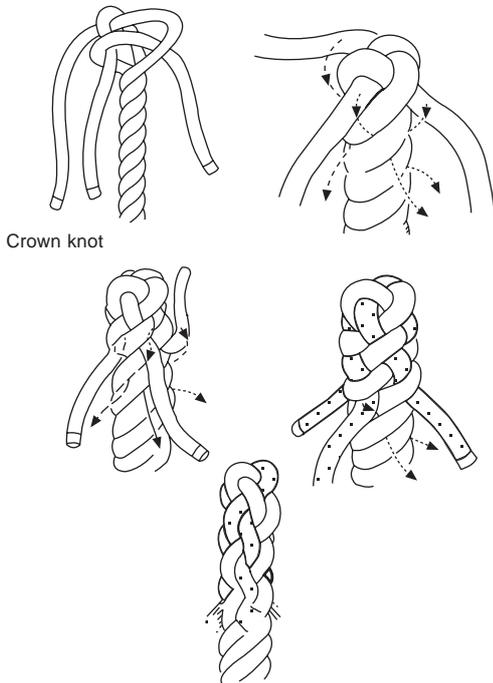


Figure 3.23 Back splice (reproduced from *Creative Ropework*).

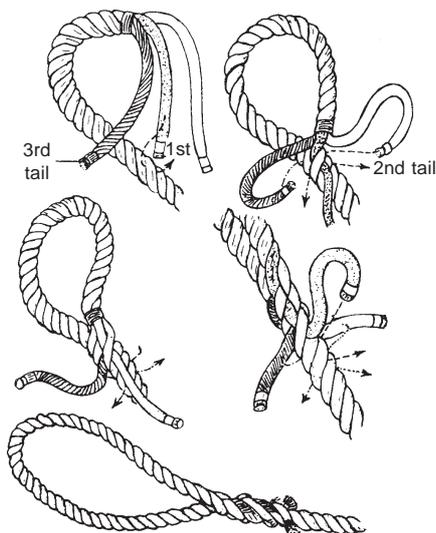


Figure 3.24 Eye splice (reproduced from *Creative Ropework*).

(75 mm) in width and turned about the wire in the direction of the lay. To ensure that the parcelling does not unravel while in the operation of serving, a lacing of sail twine may be drawn over with a marline hitch.

CORDAGE SPLICE

Back Splice (Figure 3.23)

Used to stop a rope end from unravelling, a back splice performs the same function as a whipping, though it is considerably more bulky. It is formed by opening up the strands of the rope to be spliced for a convenient length and then making a crown knot.

The crown should be pulled down tight, and then the tails can be spliced into the rope against the lay, each tail being passed over the adjacent strand and under the next. The 'first tuck' is the term used to describe the 'tucking' of each tail once in this manner. A minimum of three full tucks should be made in a natural fibre rope.

Eye Splice (Figure 3.24)

This is by far the most widely used splice within the marine industry. The eye is made by unlaying the three strands and interweaving them into the rope against the lay. It is considered a permanent eye when completed, and if spliced without a thimble, then it is referred to as a soft eye splice (as opposed to a hard eye splice with a metal thimble set inside the eye). Once the first tuck is made, the normal method of passing each tail over the adjacent strand and under the next is followed.

The first tuck is made with the centre tail being spliced first at the required size of the eye, against the lay of the rope; the second tail must be spliced next, over the immediate strand in the rope and under the following one, again against the lay of the rope; and the third and final tail must be tucked on the underside of the splice against the lay, so completing the first tuck. Each tuck in the splice should be drawn tight, but care should be taken not to over-tighten the first tuck, or else a 'jaw' may result at the join of the eye to the splice.

Short Splice (Figure 3.25)

This is a strong method of joining two ropes together, found in the making of 'bale sling stops' (see *Cargo Handling*, p. 156). The rope thickness is increased by putting in a short splice, and so it is rarely seen in running rigging, as the splice would tend to foul the block.

When making this splice, it may be necessary to whip the ends of the separate strands, and place a temporary whipping at the point where the two rope ends marry together. As more experience is gained in constructing this splice, one may probably discard the temporary whipping, unless splicing heavy duty ropes like mooring ropes.

Long Splice (Figure 3.26)

The purpose of this splice is to join two rope ends together without increasing the thickness of the rope. The splice is not as strong as a short

splice and is generally used as a temporary method of joining ropes together as they pass through a block.

Examples of the use of this splice may be seen in the renewing of flag halyards, the new halyard being long spliced to the old. The old halyard is then pulled through the block, trailing the new halyard behind it. The beauty of this system is that it saves a man going aloft and rethreading the block. It is often used in decorative ropework, where the splice must be unobtrusive.

The long splice stretches over a greater length of the rope than the short splice. It is made by unlaying a strand for up to approximately 1 m (depending on the thickness of the rope), and a similar strand is unlaid from the other rope end. This single strand should then be laid in the place of its opposite number in the other tail end. This procedure is followed with all three strands of both rope ends, so that the tail ends protrude from the lay of the rope at differing intervals. Each pair of tails should be finished off with an overhand knot in the way of the lay of the two ropes.

WHIPPINGS

Common Whipping

Probably the easiest of all the whippings (Figure 3.27(a)), it is not as strong as the sailmaker's whipping, and is liable to pull adrift with continual use. It is formed by frapping round the rope end and burying the end of the twine. Once sufficient turns have been taken, the pull through end of the twine is laid back down the lay of the rope. Frapping turns are then continued, by using the bight of the twine. Each frapping turn made with the bight is passed about the end of the rope. When the turns have made a secure tail end finish, pull through on the downhaul of the bight and trim.

There are several methods of constructing the common whipping, methods which vary with regard to the position of the whipping – whether it is made on the bight of a rope or at the tail end. Should the whipping be required in the middle of the rope, set on the bight, it would be necessary to pre-turn the whipping twine and thread the downhaul through the pre-made larger turns. Frapping could then be continued without creating 'kinks' in the twine and consequent fouling.

Any of the whippings, if constructed in a proper manner, should not be easily removed, even with regular wear and tear. This applies not only to the sailmaker's but also to the common variety.

Sailmaker's Whipping

Without doubt this is the strongest whipping in common use (Figure 3.27(b)). Should it need to be removed at a later time, it would most certainly need to be cut away.

A bight of twine is laid into the strands of the rope itself. These strands are then relaid up to form the original lay of rope, the bight of twine being left long enough to be secured by being placed about the

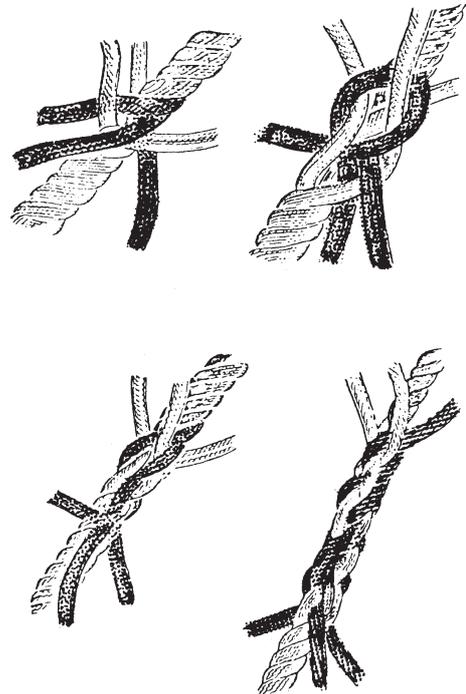


Figure 3.25 Short splice (reproduced from *Creative Ropework*).

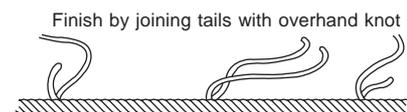
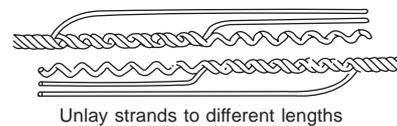


Figure 3.26 Long splice (reproduced from *The Apprentice and his Ship*).

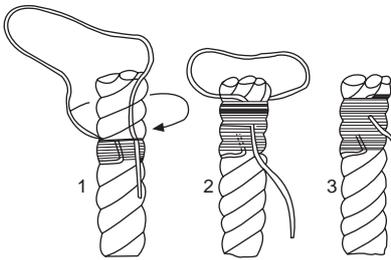


Figure 3.27(a) Common whipping.

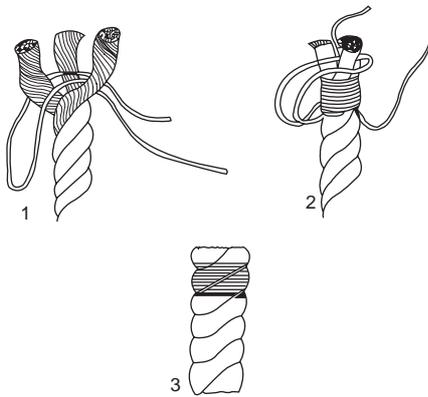


Figure 3.27(b) Sailmaker's whipping.

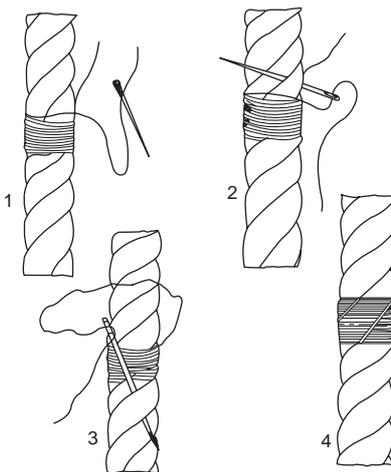


Figure 3.28 Palm and needle whipping. Used as a second whipping, set into the bight of rope to prevent lay being disturbed.

end of the identified strand, once the frapping turns have been constructed. Commence turning up the frapping turns about the tail end of the rope, having left a good length on the whipping twine. Follow the lay of the strands under the whipping and pass the bight over the same strand as shown in the figure. Draw the bight of twine tight and secure the other two ends in way of the rope lay by use of a reef knot, squeezed into the centre of the rope ends lay. The bight and long ends of the twine form a binding about the frapping turns of the whipping.

Palm and Needle Whipping

This is formed in exactly the same manner, as the sailmaker's whipping, except for the fact that a sailmaker's palm and needle is employed to 'stitch' the binding above and below the whipping (Figure 3.28). The position of the whipping is usually set well into the bight of the rope, not on the tail end, as with other more commonly used whippings. Its purpose is to add additional securing to the tail end of a rope before the end securing is placed on. It can also be used as a marker indication for set lengths of the rope.

West Country Whipping

This whipping is made in the bight of a rope and is used for marking the rope at various intervals. Although it is easy enough to construct, it is not as popular as the common whipping, which may be used for the same purpose. It would not normally be found on the tail end of a rope because the twine tends to stretch and work free with excess wear and tear; the common or better still the sailmaker's would be stronger and more suitable for the rope end. It is made by overhand knots on alternate sides of the rope, finished off with a reef knot (see Figure 3.29).

MARRYING TWO ROPES TOGETHER

It is often desirable to join two ropes together, and this may be done in many ways. The first and most obvious is by use of bend or hitch – sheetbend, carrick, reef etc. – but this method will increase the thickness at the join. An alternative is a splice, either short, cut, or two eye splices, but again the thickness of the join is prominent. For running rigging, it is generally not desirable to increase the thickness, as it would run foul of the block. A long splice is another option, but this takes time to put in.

The last option open to the seafarer (Figure 3.30) is to bring the two ropes butt end on, and use a sailmaker's needle to stitch the underside of the two whippings. The stitches, made in sail twine, must be drawn very taut to keep up the pressure between the rope ends.

If the operation is being carried out on wires, then seizing wire would be used in place of sailmaker's twine. Before joining wires in this manner, ensure that the ends of the wires are securely whipped and that the whippings will not pull off.

This method is extensively used for the re-reeving of new rigging, e.g. topping lifts, cargo runners etc.

TO PASS A STOPPER

The purpose of the stopper is to allow the weight on a line to be transferred to bits or cleats when belaying up. Examples of the use of stoppers may be found when the vessel is securing to a quay or wharf. They are used in conjunction with the transference of weight in the mooring rope from the windlass drum end to the bits (bollards).

The stopper should be secured to the base of the bits by a shackle, or around one of the bollards, so as to lead away from the direction of heaving. Mooring ropes will use a rope stopper, either the 'common rope stopper' or the 'West Country stopper', depending on the type of lay and the material of manufacture of the mooring ropes in question. The mariner should be aware that the type of rope used for the stopper is critical and the following points should be borne in mind:

1. Use natural fibre stopper for natural fibre ropes.
2. Use synthetic fibre stopper for synthetic fibre ropes.
3. The stopper material should be of low stretch material.
4. When synthetic rope stoppers are used, the material should have a high melting point, e.g. polyester.
5. The stopper should be flexible.
6. Never use nylon stoppers on nylon ropes (polyamide).

The size of the rope for the stopper will vary with the type of stopper being applied, either common or West Country. In the case of the West Country stopper the size of the rope should be as near as possible to 50 per cent breaking strain of the rope it is being applied to. Table 3.3 shows sizes for the West Country stopper. The size of cordage for common stoppers should be of a sufficient equivalent.

TABLE 3.3 Rope sizes for West Country stopper

<i>Diameter of mooring rope</i>	<i>Diameter of stopper rope (double)</i>
40 mm	20 mm
60 mm	32 mm
72 mm	36 mm
80 mm	40 mm

Common Rope Stopper

This may be used on natural fibre or synthetic fibre ropes provided they are of a hawser lay. The stopper should be examined for wear and tear before use, and if there is any sign of deterioration, the stopper should be renewed. The mariner should ensure that the stopper is secured, then pass a half hitch against the lay of the rope; the bight of the stopper between the shackle and the half hitch should be seen to be taut. Many seafarers pass a double half hitch (forming the first part of a rolling hitch), instead of just using the single half hitch. The tail of the stopper is then turned up with the lay of the rope, and held while the weight is transferred.

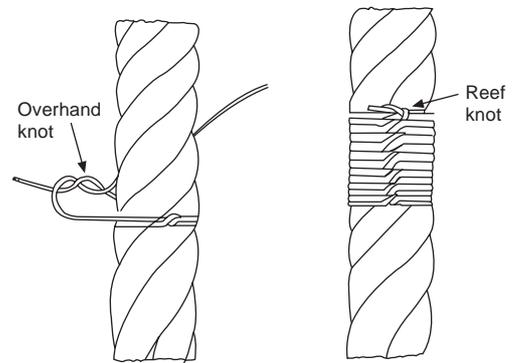


Figure 2.29 West Country whipping.

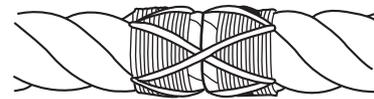


Figure 3.30 Marrying two ropes together.

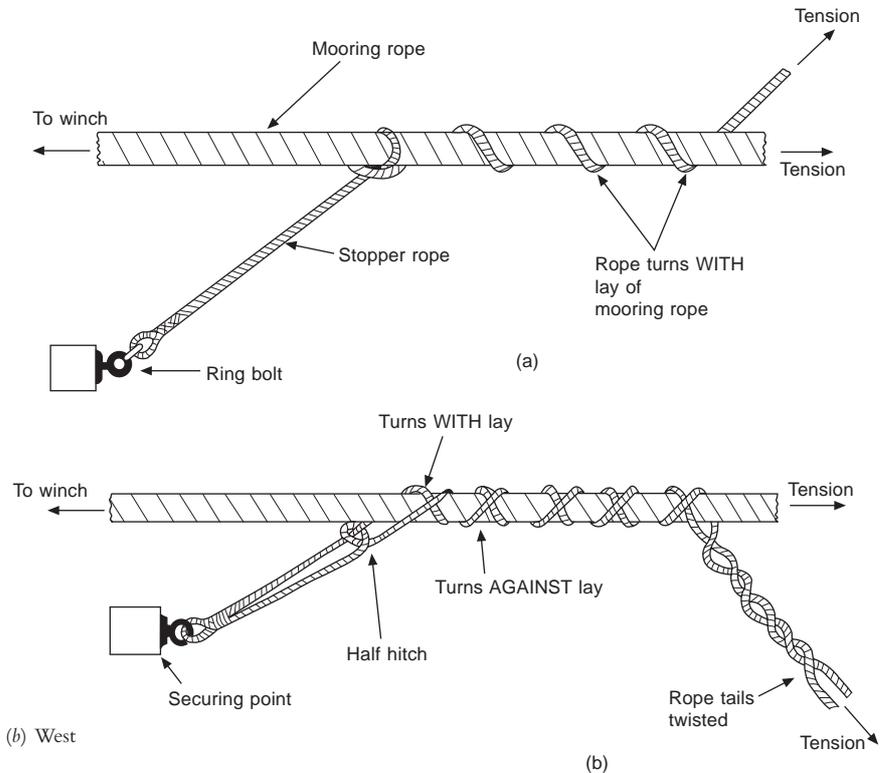


Figure 3.31 (a) Common rope stopper, and (b) West Country (Chinese) stopper.

Although used extensively for mooring, the stopper is often found useful in derrick handling and towing operations (see Figure 3.31).

West Country (Chinese) Stopper

This stopper is for use on man-made fibre ropes of either a hawser or multi-plait lay. Before use, the stopper should be carefully examined for any signs of deterioration. Although most man-made fibre ropes are water-resistant, they are subject to powdering between the strands with excessive use.

The stopper is formed (Figure 3.31) of two tails of equal length secured to the base of the bitts. The tails should be half hitched under the mooring rope to be stoppered off, and then criss-crossed on opposite sides (top and bottom) of the mooring rope. It is important to note that in the first cross of the stopper the tail nearest the rope is with the lay. When the second cross is put in on the reverse side of the mooring rope, this same tail is not the tail nearest the rope.

The criss-crossing of tails is continued about five times, then the tails are twisted together to tension up the stopper about the mooring rope.

To Pass a Chain Stopper

Chain stoppers are used for the same purpose as the common or West Country stoppers, except for the fact that they are applied to mooring wires, not ropes (see Figure 3.32).

The chain stopper consists of a length of open link chain, about 1.7 m, with a rope tail secured to the end link. The chain is shackled to the base of the bitts or to a deck ring bolt of convenient position.

The stopper is passed over the wire forming an opened cow hitch, followed by the remainder of the chain, which is turned up against the lay. The rope tail is also turned up in the same direction, then held as the weight comes onto the stopper.

The two half hitches of the cow hitch are kept about 25 cm (10 in.) apart. The mariner should be aware that a cow hitch is used and not a clove hitch; the latter would be liable to jam whereas the cow hitch is easily pulled loose when no longer required. The turns of the chain are made against the lay of the wire, so as not to open it up and cause distortion, and also weaken the wire.

BREAKING OUT MOORING ROPE

The large coil will be rotated on the swivel and turntable in the opposite direction to that in which the rope was manufactured, e.g. a right-handed laid rope should be rotated anti-clockwise. The rope itself will be hauled off from the outside of the coil, flaked in long flakes down the length of the deck, then coiled down on stowage grates. A tight coil can be achieved by first starting the coil off with a cheese, then building up the coil from the outside and working inwards to the centre (see Figure 3.33).

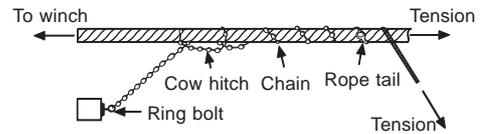
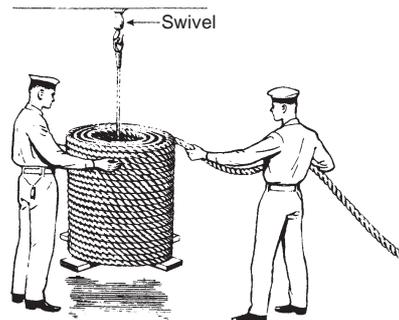


Figure 3.32 To pass a chain stopper. The example shows the stopper being passed on left-hand laid wire.



(i) Opening a new coil of small rope.



(ii) Opening a new coil of large rope.

Figure 3.33 Breaking out a mooring rope.

WIREWORK AND RIGGING



STEEL WIRE ROPE

A steel wire rope is composed of three parts – wires, strands and the heart. The heart is made of natural fibre, though recently synthetic fibre has been used when resistance to crushing is required. With the many changes in the marine industry the needs in wire rope have altered considerably from the early production days of 1840. Then the first wire ropes, known as selvagee type ropes, were constructed of strands laid together then seized to form the rope.

Modern ropes are designed with specific tasks in mind (Table 4.1), and their construction varies accordingly. However, all wire ropes are affected by wear and bending, especially so when the ropes are operated around drum ends or sheaves. Resistance to bending fatigue and to abrasion require two different types of rope. Maximum resistance to bending fatigue is obtained from a flexible rope with small outer wires, whereas maximum resistance to abrasion needs a less flexible rope with larger outer wires.

When selecting a wire rope, choose a wire which will provide reasonable resistance to both bending fatigue and abrasion. The wire should also be protected as well as possible against corrosive action, especially in a salt-laden atmosphere. Where corrosive conditions exist, the use of a galvanised wire is recommended.

All wires should be governed by a planned maintenance system to ensure that they are coated with lubricant at suitable intervals throughout their working life. Internal lubrication will occur if the wire has a natural fibre heart, for when the wire comes under tension, the heart will expel its lubricant into the wires, so causing the desired internal lubrication.

If synthetic material is used for the heart of a wire, this also acts to reduce corrosion. Being synthetic, the heart is impervious to moisture; consequently, should the rope become wet, any moisture would be expelled from the interior of the wire as weight and pressure are taken up.

TABLE 4.1 Steel wire rope

Type		Construction	Uses
SWR	Steel wire rope	6 × 6 6 × 7 7 × 6	Standing rigging
FSWR	Flexible steel wire rope	6 × 12 6 × 18 6 × 19 6 × 24	Running rigging
EFSWR	Extra flexible steel wire rope	6 × 36 6 × 37	Running rigging, where safety of life is concerned

TABLE 4.2 Formulae for breaking stresses

Type/material	Size	Factor	
Grade 1 Manilla	Natural fibre ropes	$\frac{2D^2}{300}$	
	7 mm to 144 mm		
Polypropylene	Synthetic fibre ropes	$\frac{3D^2}{300}$	
	7 mm to 80 mm		
Polythene	4 mm to 72 mm		
Polyester (terylene)	4 mm to 96 mm	$\frac{4D^2}{300}$	
Polyamide (nylon)	4 mm to 96 mm	$\frac{5D^2}{300}$	
(construction)	Flexible steel wire ropes		
	6 × 12	4 mm to 48 mm	$\frac{15D^2}{500}$
	6 × 24	8 mm to 56 mm	$\frac{20D^2}{500}$
	6 × 37	8 mm to 56 mm	$\frac{21D^2}{500}$
		Stud link chain	
Grade 1	12.5 mm to 120 mm	$\frac{20D^2}{600}$	
Grade 2	12.5 mm to 120 mm	$\frac{30D^2}{600}$	
Grade 3	12.5 mm to 120 mm	$\frac{43D^2}{600}$	

Diameter 'D' expressed in millimetres.

Breaking stress expressed in tonnes.

A comparison of the strengths of fibre ropes, wire ropes and stud link chain is provided in Table 4.2, which gives formulae for breaking stresses.

Construction of SWR

Steel wire ropes are composed of a number of thin wires whose diameter will vary between 0.26 and 5.4 mm. The thinner wires are made of hard

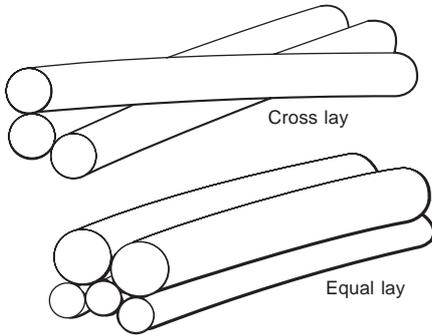


Figure 4.1 Rope lay.

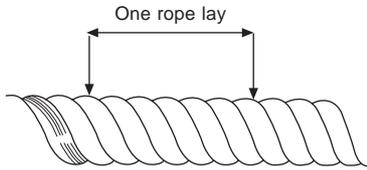


Figure 4.2 Length of lay.

drawn plough steel and the thicker wires of rolled steel. The individual wires are twisted into strands about a fibre core or a steel core, or even laid up without any form of centre heart.

These strands are in turn laid up about a fibre or steel heart, or just laid up together without any centre core. The direction of laying up the wires and laying up the strands is critical. If the wires are laid in the same direction as the strands, then the hawser is said to be a 'flat strand hawser', whereas if the wires are laid up in the opposite direction to that of strands, then the wire is said to be a 'cross-laid hawser'.

Ordinary Lay

A rope of ordinary lay is one where the direction of lay of the outer layer of wires in the strands is opposite to the direction of lay of the strands in the rope. Most wire ropes are laid right-handed, but left-handed ropes may be obtained (Figure 4.1).

Variations in the length of lay (see Figure 4.2) will alter the elastic properties of the rope. For example, shortening the length of lay will increase a rope's elastic stretch properties but will reduce its breaking strain.

Equal Lay

In this type of construction the wires of a strand all have an equal length of lay. Consequently contact between wires is of a linear nature (see Figure 4.1).

Lang's Lay

This construction is one where the outer layer of wires in a strand is the same direction as the lay of the strands of the rope. Like ordinary lay, Lang's lay is generally found as a right-handed laid rope, but may be manufactured as a left-handed as well (Figure 4.1). It offers a greater wearing surface and can be expected to last longer than an ordinary laid rope, especially when used in work where resistance to wear is important. However, a rope of Lang's lay construction has a low resistance to unlaying, and it is usually restricted to applications where both ends of the wire are secured against rotation.

Cross Lay

A cross lay construction is one in which the wires in successive layers of the strand are spun at approximately the same angle of lay (Figure 4.1). It follows that the wires in successive layers make point contact. Where ropes are operating over sheaves and drums, nicking of wires together with secondary bending at these points of contact occur, and failure of the wires due to early fatigue may result.

Spring Lay

The form combines galvanised wires with tarred sisal. Six ropes of tarred 3 stranded sisal are inlaid with three strands of wire each containing

nineteen wires per strand, and the whole is laid about a central fibre heart.

Its strength is not as great as ordinary wire rope, but the advantage of spring lay is that it is easily handled and coiled, and is about three times as strong as a grade 1 manilla rope of equivalent size. Similar combination ropes are in extensive use within the fishing industry, but when encountered on merchant vessels, they tend to be employed for mooring or towing springs, as they have a very good shock resistance.

Seizing Wire

This wire is usually seven-stranded, having six single wires laid about a seventh wire of the same size. It is in general use aboard most vessels where additional strength is required over and above that provided by a fibre seizing. It is specifically used for mousing shackles, marking anchor cable etc. where the bearing surface is metal.

The general practice of good seamen is not to use seizing wire for the purpose of mousing hooks, since the shape of the bill of the hook may allow the mousing to slip off. To this end a fibre mousing is more common, either in spunyarn or other similar small stuff, depending on the size of the hook (see Figure 4.18).

Lubrication

Steel wire ropes are lubricated both internally and externally in the course of manufacture, to provide the wire with protection against corrosion. During its working life the rope will suffer pressure both externally and internally as it is flexed in performing its duty. The original lubricant may soon dry up and it will be necessary to apply supplementary lubricant at periodic intervals.

Main Core (Heart)

Within the shipping industry the majority of steel wire ropes, of the flexible nature, are equipped with a hemp or jute natural fibre heart. The non-flexible wires are usually built up about a steel core. The natural fibre heart is impregnated with grease, to supply internal lubrication when the rope comes under tension.

Preforming

This is a manufacturing process which gives the strands and the wires the helical shape they will assume in the finished rope. Preformed rope has certain advantages over non-preformed:

1. It does not tend to unravel and is less liable to form itself into loops and kinks, making stowage considerably easier.
2. It is slightly more flexible and conforms better with the curvature of sheaves and drums.
3. It provides reduced internal stresses and possesses a greater resistance to bending fatigue.

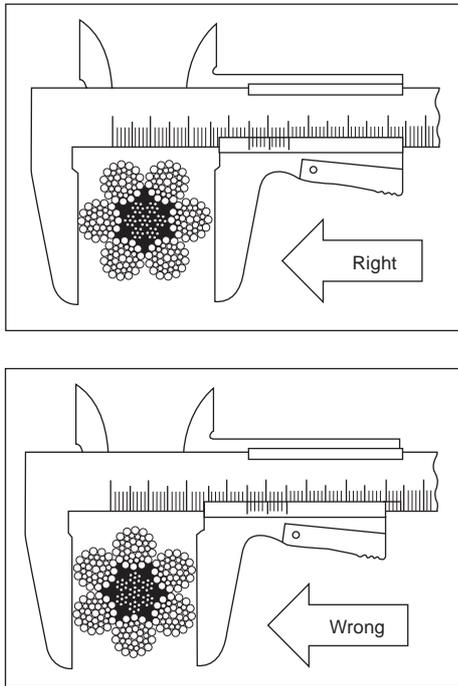


Figure 4.3 Measuring steel wire rope – by diameter of circle enclosing all strands.

When cutting preformed wire rope, it is not essential to whip the bight either side of the intended cut, though it is good practice to do so. Whippings should be applied to all non-preformed wires when they are to be cut.

Measurement

This is carried out by the use of a rope gauge (see Figure 4.3).

STEEL WIRE ROPE RIGGING

Standing Rigging

This will be of 6×7 (6 strands, 7 wires) construction, or, with a steel core, 7×7 construction. For larger sizes 6×19 or 7×19 may be encountered. Examples in use would be the shrouds to port and starboard of the mast, forestay, backstay, triatic or what used to be called jumper stay, ships' wire guard rails etc (see Figure 4.4).

In standing rigging the wire is non-flexible, and under normal circumstances it is a permanent fixture of the vessel in that it does not or will not be moving at any time. There are exceptions to this, e.g. preventer backstays to a mast when operating a heavy lift derrick, ships' guard rails being removed to allow access.

Running Rigging

These are flexible ropes of 6×12 , 6×18 , 6×19 , 6×24 , 6×36 or 6×37 construction. The number of wires per strand (wps) may be as many as 91, but these ropes are generally confined to heavy industry, such as launching slipways, towage and salvage operations, as opposed to the normal working marine environment.

Running rigging examples may be seen in lifeboat falls, topping lifts for derricks and cranes etc. As a general description, any wire, or cordage for that matter, passing over a sheave or about a drum may be classed as running rigging (see Figure 4.5).

Forestay

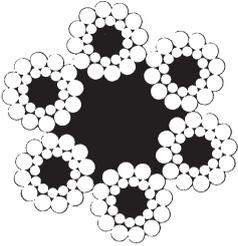
This is a wire stay secured to the mast table and running forward to the fo'c'sle deck. It is usually made either of 'iron wire rope' 7×7 or 'steel wire rope' 7×7 or 7×19 , and secured by a rigging screw in the forepart. It is now no longer common practice to use iron wire rope, as the masts of modern vessels accommodate cargo-handling gear and the load stresses could be too great.

Topmast Stay

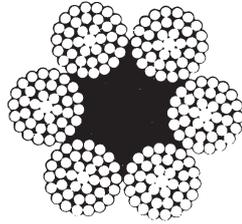
This is a steel wire running in the fore and aft line which may be secured either forward or aft, depending on the position of the topmast. It is secured to the hounds band of the topmast at one end, and at the other end at deck level with a rigging screw. Construction is 6×7 or 7×19 .

The mariner should be aware that for maintenance purposes, or to

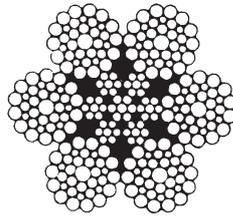
MOORING LINES



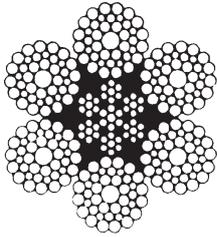
6 x 24



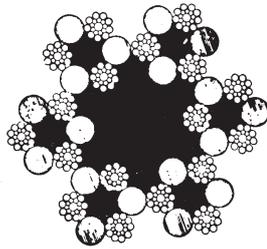
6 x 37



6 x 36

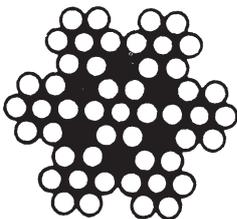


6 x 41
(Steel core)

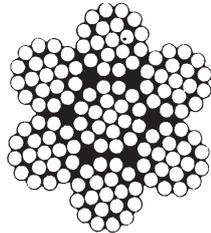


6 x 3 x 1
(Spring lashing wire)

STAYS AND SHROUDS STANDING RIGGING

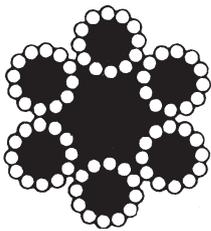


7 x 7 (Steel core)



7 x 19

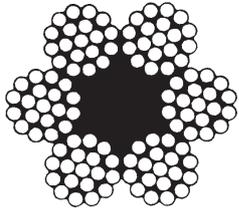
CARGO LASHING WIRE



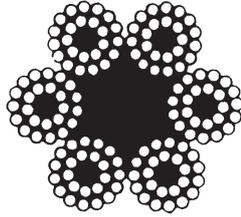
6 x 12
(Fibre heart)

Figure 4.4 Varieties of wire rope for mooring, standing rigging and cargo lashing.

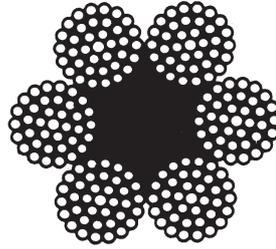
CARGO HANDLING GEAR & RUNNING RIGGING (all with fibre heart)



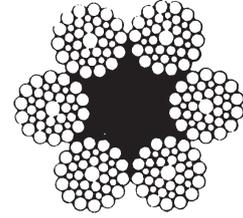
6 x 19



6 x 24

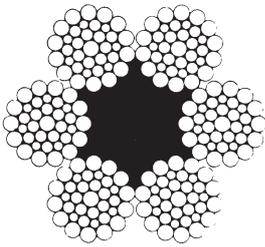


6 x 37

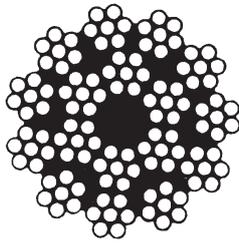


6 x 36

DECK CRANES

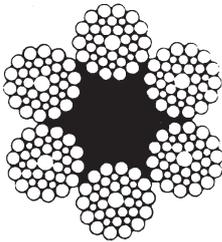


6 x 36



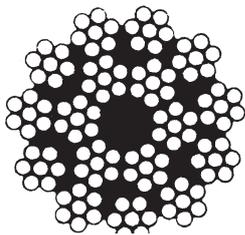
17 x 7

DERRICK TOPPING LIFTS

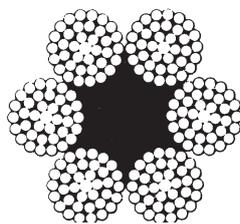


6 x 37

LIFEBOAT FALLS



17 x 7



6 x 36

Figure 4.5 Varieties of wire rope for running rigging, deck cranes, derrick topping lifts and lifeboat falls.

allow greater access for cargo working, the forestay and the topmast stays are often removed. The construction and size of these stays make it essential that, when the rigging screws of either stay are removed, the weight of the stay is taken up by a handy billy or equivalent purchase. The handy billy is rigged from the stay to a convenient deck bolt so as to take the weight off the rigging screw, allowing its removal and the controlled release of the stay by easing out the handy billy purchase.

Jumper Stay

An old-fashioned stay now very rarely seen, the jumper stay fell out of use when the signal stay and triatic stay became popular. The name 'jumper' was acquired from the early sailing ships, which carried a block secured to this stay; a single whip passed through the block and light bagged cargo was discharged by securing one end of the whip to the bags, while the other was held by a seaman who 'jumped' down to the quay from the ship's side. This action caused the cargo to be raised and discharged overside – not a very practical method by today's standards but effective for the day.

The stay was made of steel wire rope standing rigging usually of $1\frac{1}{2}$ or 2 in. (12–16 mm) circumference, six strands being laid about a steel core right-handed. The jumper stay, when fitted as such, extended from the after mast to the foremast. This later gave way to the fitting of what is now termed the signal stay, which ran from the foremast to the funnel, leaving the jumper stay to become a so-called continuation from the aft side of the funnel to the after mast, until eventually it became obsolete.

Triatic Stay

This is a stay that runs from the foremast to a secure position over the Monkey Island/Bridge. The stay was often secured to the funnel on many of the three-island type vessels, but for the stay to be effective, it was necessary to reinforce the thin metal work of the funnel with a doubling plate. This reinforcement allowed the tension to be taken in the triatic stay, and permitted that stay to work in the desired direction of opposition to the forestay.

Several of the old 'Kent' class cruisers of the Royal Navy secured the triatic stay between the fore and after masts, in the place of the jumper stay. This stay was made of $1\frac{1}{2}$ in. (12 mm diameter) flexible steel wire rope, a construction not to be expected on a merchant vessel, where the common type of triatic stay is standing rigging of a 6 × 6 or 6 × 7 nature.

Shrouds

The function of shrouds is to provide the mast with staying support to port and starboard. They are secured under the mast table (if fitted) or to the hounds band of the mainmast structure. They are now given as wide a spread as possible without interfering with derrick or crane operations, to provide not only athwartships support but a fore and aft support as well. The smaller vessel often has shroud made of round iron bar, but the

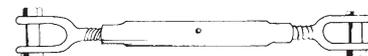
Bottle screws (Turnbuckles)

Rigging bottle screw \varnothing employed for standing rigging, manufactured in mild steel



Solid thimble

Stretching screw \varnothing mild steel, jaw and bolt fittings



Stretching screw (Admiralty pattern) \varnothing galvanised, mild steel



Senhouse slip

Awning screw \varnothing galvanised steel



Figure 4.6 Bottle screws.

Wire Rope Fittings

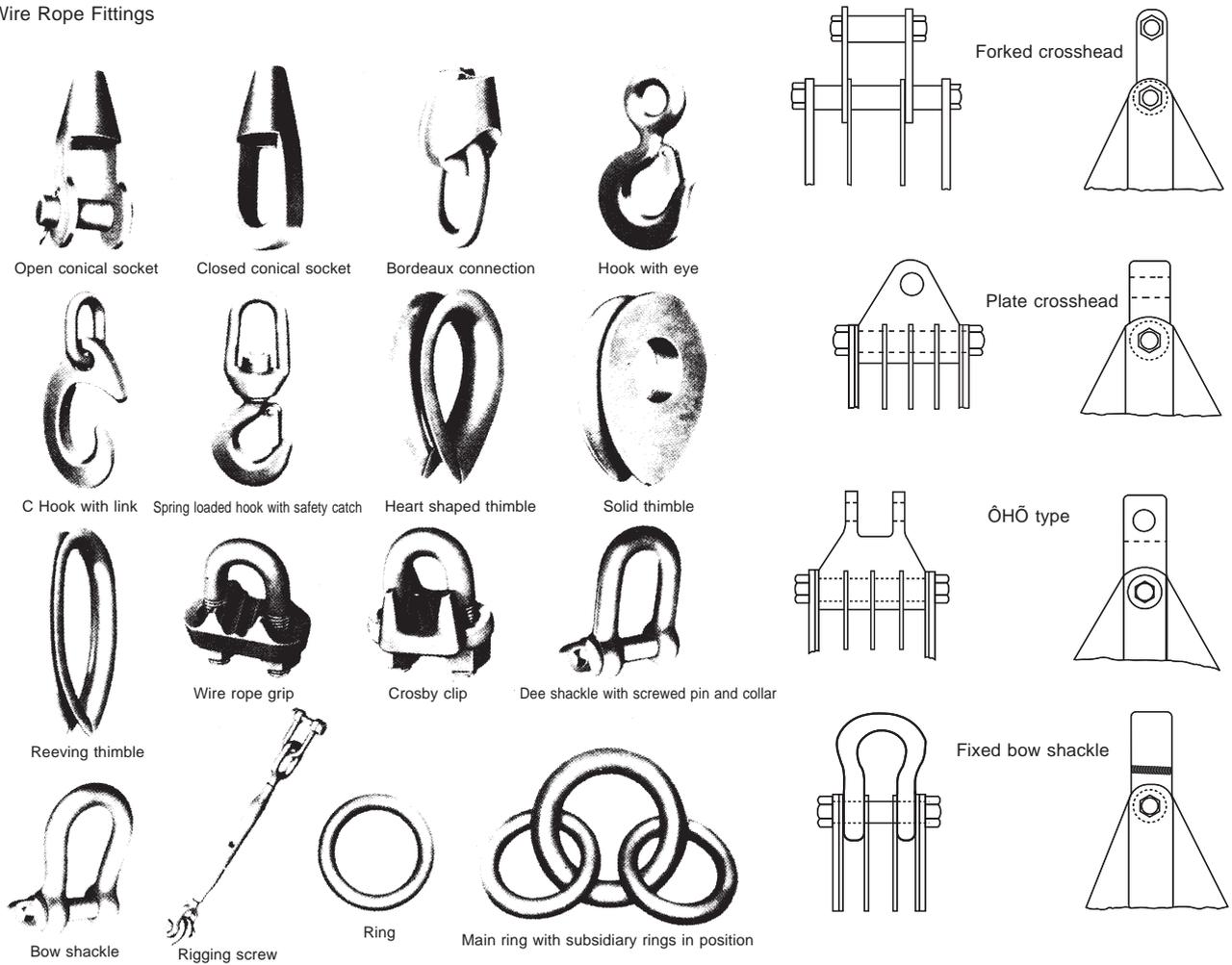


Figure 4.7 Wire rope/rigging, and heavy lift block fittings.

more general construction material is steel wire rope, 6 × 7, laid about a steel core.

The number of shrouds fitted varies with the vessel's length and deck design, and with the height and expected stresses that the mast will be required to handle. Three or four shrouds are common, and more recently, where four shrouds are fitted, they are secured in pairs, providing longitudinal as well as athwartships support. When an odd number of shrouds are required, the single shroud, which is left unseized, is known as a swifter, the double pairs of shrouds being seized under the mast table.

All shrouds are secured at deck level by a rigging screw shackled into a hard eye, with a solid thimble set into each end of each shroud. The solid thimble accommodating the pin of the shackle prevents movement

of the shackle within the eye of the shroud, and provides a certain amount of rigidity about the shroud. The rigging bottle screw is usually secured against movement by being locked with a locking bar or locking nuts, which prevent accidental unscrewing of the bottle screw.

Preventer Backstay

This is a general term used for describing stays that act in opposition to the general direction of weight. They are extensively used when a 'jumbo' heavy lift derrick is in use; they are then temporarily rigged to support the additional weight that the mast will bear.

The term is also used for stays having a lead opposite to the forestay, which are often led to port and starboard as with the normal shrouds. Their construction is the same as for standing rigging, and they are secured by rigging screws at deck level (see p. 89).

RIGGING FITMENTS

Blake Slip

This is used mainly in anchor work aboard naval vessels. It is a rigid style of slip not having the versatility and hence not as popular as the Senhouse slip (see Figure 4.11).

Conical Sockets

Nearly all shrouds and stays will be secured by use of a rigging bottle screw, but it is a point worth mentioning that the rigging screw (Figure 4.6) will usually be secured to the stay by one of two methods: the hard eye, with the solid thimble, is still in common use, but with better facilities ashore for engineering the use of the 'open conical socket' and the 'closed conical socket' is becoming more and more popular (Figure 4.7). The wire is sweated into the socket by heat treatment about 300°C, when the socket expands and accepts the wire.

Pad Eye

A common fitment (Figure 4.8) aboard most modern vessels, it may be riveted, bolted or welded to the bulkhead or deck.

Quick Link

This supplies a quick method of joining or repairing chains. The advantage of this link is that it may be released even when under tension, as the stress is bearing at the ends of the links, not about the screw thread.

The disadvantage is that the link cannot be used with chain made from bar which has a larger diameter than that of the link itself. However, it is manufactured in various sizes, in mild steel zinc-plated and in stainless steel (see Figure 4.9).

Screw Eye Bolt

This is secured by passing the bolt through a bulkhead or deck and fixing



Figure 4.8 Pad eye.

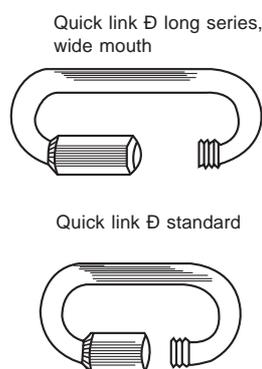


Figure 4.9 Quick link.

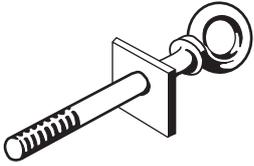


Figure 4.10 Screw eye bolt.

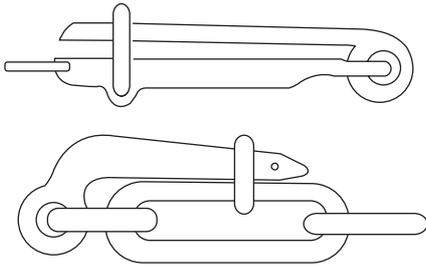


Figure 4.11 Blake slip (above) and Senhouse slip (below)

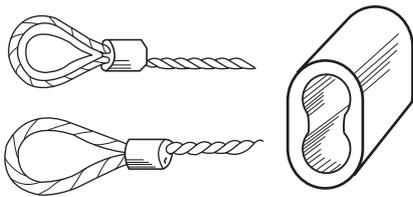


Figure 4.12 Talurit clamp.

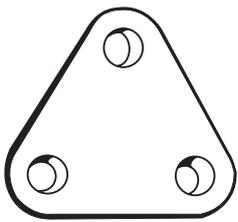


Figure 4.13 Triangular plate.

a locking nut from the other side. It is popular as a temporary rigging fitment (Figure 4.10).

Senhouse Slip

This is a common fitment (Figure 4.11) aboard most modern vessels and encountered in a variety of sizes. Examples in use may be seen securing the web straps over life rafts or in the gripes securing lifeboats.

Talurit Clamp (ferral)

Tests have shown that use of the Talurit clamp (Figure 4.12) is probably the strongest method of putting an eye in the end of a wire. The method is most certainly stronger than an eye splice or a socket.

The ferrule, whose passages have a diameter corresponding to that of the wire rope, is fitted into position loosely about the two parts of wire. If a hard eye is required, then a thimble would be inserted at this stage. The ferrule is then compressed about the wire by a very powerful Talurit (press) machine. The disadvantage of this method is that the machines are expensive and will accommodate only up to certain size of wires. For practical purposes it is therefore a method which is generally employed as a shoreside occupation.

Thimbles

The purpose of a thimble (Figure 4.7) is to protect and reinforce the eye of the rope or wire. There are three main types.

The *open heart thimble* is probably the most widely used within the marine industry, generally in conjunction with a shackle or ring bolt. Its freedom of movement in all directions depends on the size of shackle and the size of thimble.

When set into the end of a wire or rope, its construction forms what is known as a hard eye, as opposed to a soft eye when the thimble is not in position. When inserting thimbles to make a hard eye, a tight splice will be required to retain the thimble in position. A slack splice would allow the thimble to become slack, and soon drop away (see Table 4.3 for cordage table).

The *round thimble* is generally found spliced into natural fibre cordage, forming a hard eye. The shape of the round thimble does not lend itself to being spliced into steel wire.

Examples in use may be encountered in the painter of a ship's lifeboat, shackled down to a ring bolt in the forepart of the bowsheets. Another use is found in the eye of a lizard when employing stages. The heart thimble has gained in popularity because its shape is more suited to form the eye, but the round thimble has the same function of protecting the cordage.

The *solid thimble* is used only in standing rigging, such as stays and shrouds. The solid thimble does not allow any movement of the pin of the shackle connected to it, and so provides a more rigid standing structure.

TABLE 4.3 Cordage table for use with open heart thimble

Rope diam. mm	A mm	C mm	D mm	G mm	K mm	Q mm
8	22	13	33	4	4	30
9	25	14	38	6	5	35
10	29	18	41	8	5	38
11	29	18	41	8	5	38
12	29	18	41	8	5	38
13	32	21	44	8	6	43
14	32	21	44	9	6	43
16	41	22	59	9	8	57
18	44	29	67	10	8	60
19	51	29	73	11	10	70
20	51	29	73	11	10	70
22	57	32	83	13	10	76
24	64	33	92	13	10	84
26	70	35	108	14	10	91
28	76	38	111	16	13	102
32	95	41	133	16	13	121
35	105	48	152	19	16	137
36	105	48	152	19	16	137
38	114	54	165	24	18	149
41	114	56	165	24	18	149
44	127	57	178	25	25	178
48	133	67	191	29	29	191
51	140	70	203	30	29	197
54	140	70	203	30	29	197
57	146	76	216	32	30	206
64	159	95	241	44	32	222
70	203	121	273	60	41	286

Triangular Plate

Referred to by seamen as a 'union plate' or as a 'monkey face plate', it is used extensively in the rigging of two derricks in a union purchase rig, taking the place of a union hook or Seattle hook. The cargo runners are shackled directly on to the plate to form the union of the whips. It is also used on a single span topping lift, providing an attachment for the chain preventer and the bull wire (see Figure 4.13 and 5.2).

WIRE SPLICING

There are many types of wire splices possible but these days the short, long and cut splices are rarely seen. The eye splice, of which there are several variations, is by far the most common.

A locking splice is considered to be the most desirable for the majority of tasks encountered at sea today. The lock is formed by tucking two tails under one strand but in opposite directions, so that they cross under the tucked strands. The 'Boulevard Splice' is described in the following text.

The setting-up process of any wire splice may be compared to the

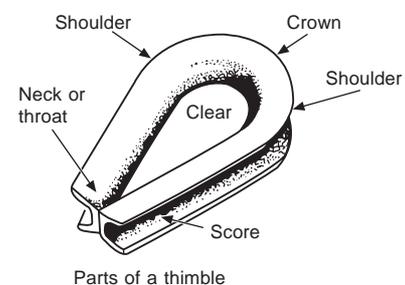
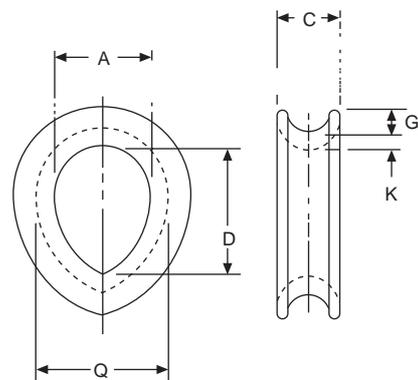


Figure 4.14 Thimble.

foundation of a building. If it is not set correctly, the construction of the splice will very quickly fall apart.

Depending on the type of wire being spliced, whether it is of the preformed variety or not, the strands will unlay a certain amount once lengths of wire are cut from the reel or coil. Always whip the bare ends to be left on each side of the proposed cut, so preventing wastage from the coil. The strand of any wire *not* of the preformed (see p. 85) type will tend to unlay. Non preformed wire, will unlay when cut or allowed with its bare end, to be used without a whipping.

A whipping should also be set on the wire at the point the splice is to begin. The required size of eye should be made in the bight of the wire and both parts of wire should then be seized securely together. If a thimble is to be inserted, so making a hard eye, then this should be placed inside the bight of the eye before applying the seizing. The thimble is secured in position by light seizings, about the crown and shoulders of the thimble (Figure 4.14).

The end of the wire should then be unlaied, exposing the heart. Each tail unlaied should be whipped at the end to prevent the individual wires from unlaying and distorting the strand. Each tail (unlaied strand) should be unlaied back as far as the seizing joining the two parts of wire forming the eye. The heart should not be cut away at this stage as it will be useful

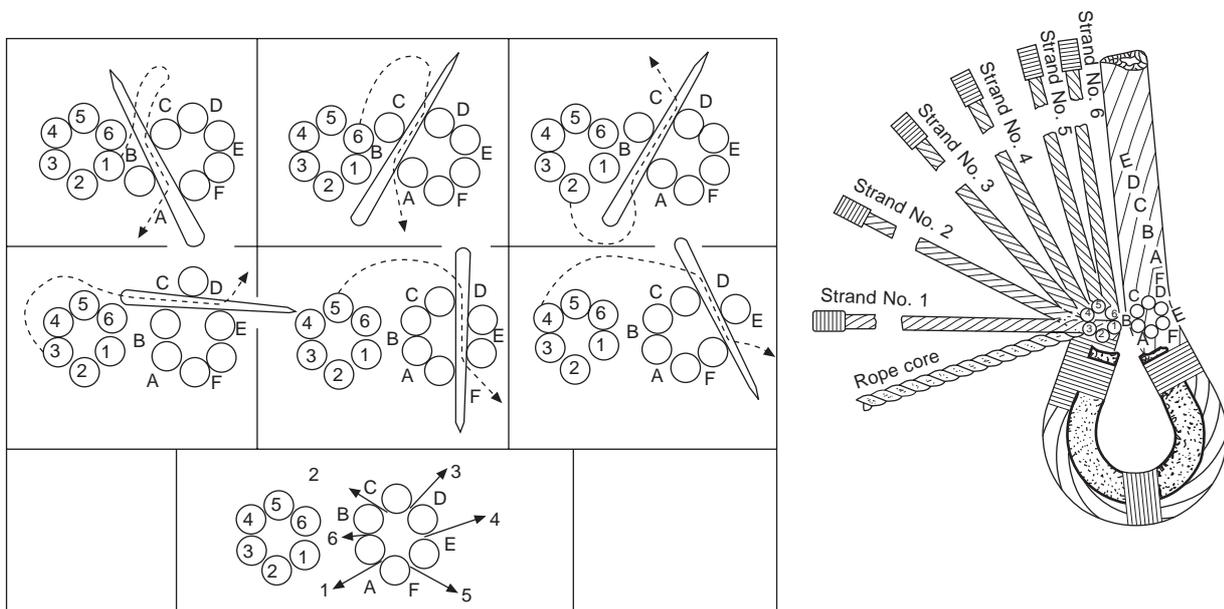


Figure 4.15 Construction of the Boulevant wire eye splice.

All wire ropes will require some preparation before splicing. Where a hard eye is to be constructed the thimble must be seized into position first.

All the separate tails should have their ends whipped to prevent them unlaying during the splice operation. The standing part of the wire should normally be lashed high in the vertical to allow the seaman to work more easily around the wire. If a heavy wire is being spliced, a Spanish windlass may be required to draw both parts of the wire together around the thimble. Once both parts are closed up, then a strong seizing should join the two above the thimble position. The heart should not be cut from the wire until the splice is complete.

later in splice construction, apart from the fact that a neater splice is obtained by tucking the heart at the commencement of the splice.

This is a wire eye splice (Figure 4.15) having a lock in the first set of tucks. Number 2 and 6 tails will form the lock of the splice, and the subsequent construction will be followed by two full tucks of all the six tails (unlaid strands). These tails will then be halved and two subsequent half tucks will then complete the splice.

Once the wire has been set up in the vertical position in the vice, identification of the tails may be made by pulling the heart between the two tails which are closest to the standing part of the wire. The two tails are then identified as 1 and 6, either side of the heart. The remaining tails from 1 in a clockwise direction may be identified as 2, 3, 4, and 5, to end at number 6, next to the heart.

Insert the marline spike under the strand in the standing part, which is closest to number 1 tail, and as near to the thimble as possible. Care should be taken not to over-spike the wire and cause excessive distortion. Tuck the heart under the lifted strand, then tuck number 1 tail through the same opening but on top of the heart. Both the heart and tail 1 should be tucked in the direction of the tapered end of the spike (with the lay).

Where the heart and number 1 tail exit from the standing part identifies the opening 'A' of the wire. By moving clockwise, the openings B, C, D, E, and F may also be noted.

The following is the sequence of tucking the tails for the first tuck:

<i>Tail number</i>	<i>Enters at</i>	<i>Exits at</i>
1	B	A
6	C	B
2	B	C
3	C	D
5	D	F
4	D	E

It should be borne in mind that the first tails tucked, namely 1 and 6, should be tucked in the direction of the taper of the marline spike, with the lay, whereas all subsequent tails should be tucked from the direction of the handle of the spike, against the lay. Although a difficult thing to see from the sequence of tucks on paper, in practice the mariner will clearly see that the tails 6 and 2 form the lock under strand 'B'.

After the first tuck has been completed, it should be tightened by pulling down on each tail separately. A gentle tapping of the tails to knit into the strands with the handle of the marline spike will not do any harm, but care should be taken not to overdo this, as broken wires may result.

It will be observed that after the first tuck each tail exits from the standing part from a separate opening. The splice is continued by tucking each tail over the adjacent strand and under the next – over one, under one, so to speak, as in fibre rope splicing. The second tuck is completed

NB. Some Administrations no longer accept hand spliced wires aboard the vessel and expect all wires to have 'Talurit Clamp' eyes.

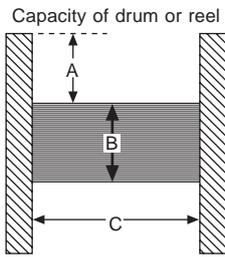


Figure 4.16 Size of stowage reels. The following formula may be used to work out the rope capacity of any size drum or reel. It will produce reasonably accurate results for evenly spooled wire rope, but less accurate results for wire not so spooled.

$$\text{Formula: } \frac{A}{d} \times \frac{C}{d} \times \pi(A + B) = \text{Capacity}$$

where d = diameter of wire.

The flange A will extend beyond the outer layer of rope, and the dimension A should be taken to the outside of the rope only, not to the outside of the flange.

as each tail is tucked twice, this procedure being continued for a third and final full tuck. Each tail is tucked a total of three times.

When tucking the tails, it is important that the tails themselves do not become crossed. This can be avoided by tucking the tail on the inside, not the outside, of the next tail to be crossed.

After three complete full tucks have been inserted, and each tuck tightened up, two half tucks should be inserted to taper and complete the splice. The taper is carried out by splitting each tail in half, separating the wires of each tail into two equal sections. One section will be seen to be a tighter lay than the other, and this half of the tail is the one to be used in making the half tuck. The other will be cut off. Each tail is split in the same manner, then spliced as for the second tuck, 'over one, under one'. The operation of splitting the strands effectively reduces the cross-sectional diameter of the splice, and the two half tucks produce the desired tapered effect.

After the locking tuck, two full tucks, and the two half tucks have been inserted, and each tuck tightened up on completion, the half tails left should be chopped off as close to the standing part as possible. A cold chisel on a firm surface is effective for chopping the tails. The heart should then be 'vee'd' (cut in a V on either side of the strands next to the heart).

STOWAGE OF WIRE HAWSERS

Wire hawsers are generally stowed about the cylindrical centre part of a reel specifically designed to accommodate the size of wire (Figure 4.16). Often the reels are equipped with a gearing ratio to allow easier manual operation; and, strictly speaking, if the reel is geared, it is a winch in the true sense of the word. However, it is common practice for seamen to refer to geared or ungeared drums simply as reels.

The wire should never be shackled to a reel, as this practice would prove extremely hazardous should weight come on to the wire at the bare end while it was still secured to the reel. The result could well be that the reel could be torn from its deck mounting by the weight on the wire, causing excessive damage and possible serious injury. Wire hawsers should be secured by a light fibre lashing (small stuff) which would part easily under strain without ripping the reel from the deck (see Safe Handling Procedures below).

SAFE HANDLING PROCEDURES FOR WIRE ROPE

1. Wire ropes should be regularly treated with suitable lubricants.
2. Wires should never be used directly from the stowage reel, unless the reel is purposely designed to allow direct operation; for if the wire should foul when running, the reel and its supporting frame may be torn from the deck mountings, causing serious injury to seamen.
3. Sufficient slack should be taken from the reel to provide adequate length to cover all contingencies. Should any doubt exist as to the

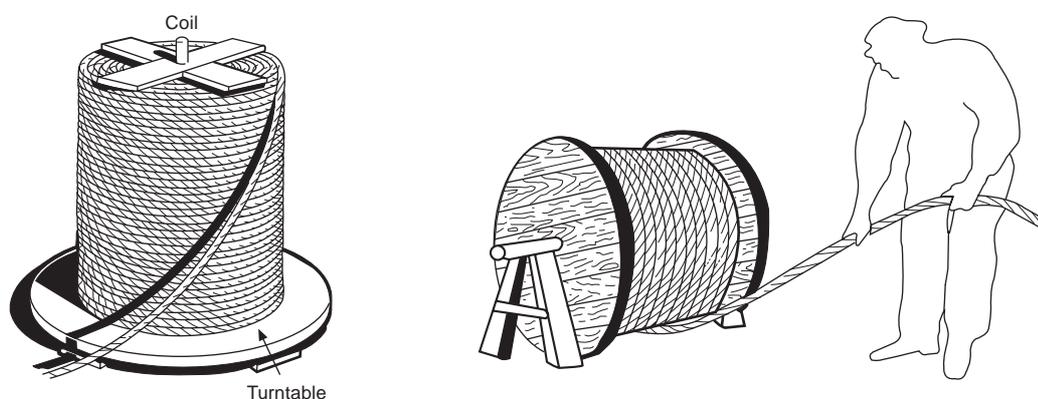


Figure 4.17 Opening a new coil of steel wire rope. A two-man job, where one man will flake out the wire down the deck while the other will ensure that the turntable rotates steadily. The turntable method is popular at sea because, when not in use, the table lends itself to easy and convenient stowage.

amount of slack that will be required, then all the wire should be removed.

4. When wires and ropes are under strain, perhaps in a towing operation, persons should stand well back in a position of safety.
5. Sharp angles on wire rope leads should be avoided.
6. When awkward leads are the only alternative when handling wires, as with cargo winch use, then snatch blocks should be suitably sited and secured sufficiently to prevent them from braking loose.
7. When wire ropes are turned up about bits, then the top turns should be secured against springing off, by a light lashing.
8. When wire rope is to be joined to a fibre rope, then the fibre rope should be fitted with a thimble, so preventing chafe and wear about the eye.
9. Wire ropes should never be led across fibre ropes and allowed to cause chafe.
10. Chain stoppers should be used on wire ropes.
11. Wire on drum ends should not be used as check wires.
12. Should a wire rope be used as a slip wire, then the parts of the eye should be seized together and reduced in size to allow passage through the ring of the mooring buoy.
13. When breaking out a new coil of wire, care must be taken, and a turntable used whenever possible (Figure 4.17).

MOUSING A HOOK OR SHACKLE PIN

The purpose of mousing a hook is to prevent the object being lifted or the hook from breaking adrift. Small stuff, for example spunyarn, is seized about the back of the hook and around the bill, effectively closing off the clear.

The objective of mousing the bolt or pin of the shackle is to prevent the shackle working itself free when in normal regular employ. Seizing wire is used, because of its robust character. It is passed inside the clear and through the end of the bolt in a 'figure eight', so preventing withdrawal of the pin (see Figure 4.18).

If unreeling, pass a shaft through the coil of wire and pull out the wire, flaking it down the length of the deck before coiling or running it on to a stowage reel. A second man should control the rate of rotation of the coil with this method.

Should no turntable or reel arrangement be available, then no attempt should be made to unravel the wire while keeping the coil flat on the deck. This method will only result in the wire becoming excessively kinked. Roll the coil down the deck, allowing the wire to fall off in flakes.

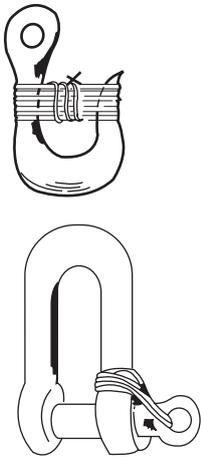


Figure 4.18 Mousing a hook or shackle pin.

A spring-loaded tongue is often found on hooks which are in continual use instead of the temporary mousing, e.g. cargo hooks. (Below) Mousing a shackle.

BLOCKS – CARE AND MAINTENANCE

Before loading or discharging with ship's gear, inspect all blocks carefully, paying special attention to the following:

1. *Swivel head fittings.* Examine the nut or collar of the shank, to ensure that it is securely fastened and free from any visible defect. The shank should be checked for distortion and be seen to turn freely by hand. Any clearances should not be excessive. Grease or oil the swivel fitment.
2. *Binding.* Examine the side (binding) straps for fractures or corrosion. Ensure that the block number and SWL are distinctive.
3. *Side or partition plates.* Check that there is no distortion or buckling that would allow the wire to jam between the cheeks and sheaves.
4. *Sheaves.* Examine for cracks in the metal and check that the bush is not slack in the sheave or causing excessive wear on the axle pin. Each sheave should be seen to turn freely by hand. Sheaves worn in the groove could cause excessive ropewear and should be checked whenever a new rope is to be rove.
5. *Axle pins.* Check axle pins for wear, and ensure that they do not rotate. They should be securely held in position by a holding nut. If a split pin is passed through, it should be frequently renewed.
6. *Lubrication.* Regular lubrication of all moving parts must be carried out over the life of the block and the efficiency of the rig will be impaired. Lubricants must be adequate, and any old congealed lubricants should be removed before applying fresh grease or oils.
7. *Protection.* Blocks may be painted, provided that grease nipples are not covered or moving parts choked sufficiently to impair their function. Reference marks should be left clear.

Ordering Blocks

1. Provide the title of the block, e.g. snatch block.
2. Provide the safe working load of the block.
3. Provide detail of internal or external binding.
4. State the diameter of the sheave.
5. State the size of wire or rope to be used with the block.
6. State what type of fitments, if any, are required.
7. State the purpose for which the block is to be employed and give a brief description of the material of manufacture, e.g. wood, metal, galvanised etc.
8. State if a test certificate is required.

Wood Blocks

There are many wooden blocks available on the commercial market but their popularity has waned with the production of a stronger, more practical and cheaper metal version.

The *internal bound wood block* (Figure 4.19) comprises a wood shell built around the metal binding, which is fork-shaped and passes through the crown. This binding will have a hook or eye attached and will be left

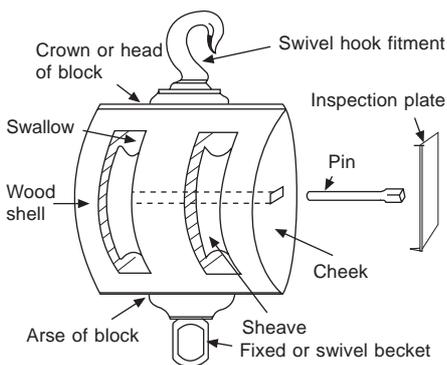


Figure 4.19 Two-fold, internal bound, wood block.

Information on inspection plate

Safe working loads of block (a) when used as an upper block and (b) when used as a lower block.

Size of rope or wire for use with the block.

Certificate number (block number).

Date of certificate of testing the block.

exposed over the crown, while a becket, if fitted, will protrude from the arse of the block.

The wooden shell, as with the majority of wood blocks, is made of elm, the sheaves being manufactured in brass, phosphor bronze or galvanised steel. The old-fashioned sheave used to be made of *lignum vitae*, but these are rarely seen on a modern vessel.

The *external iron bound block* is similar in construction to the one above, except that the binding is exposed about the shell of the wood block. The fitments may be fixed or swivel hook, or eye, at the crown, an eye becket being an optional addition.

The *common block* is a very old-fashioned block and as nearly obsolete as one may encounter. It was made entirely of an elm wood shell strengthened by either a single or double strop. The strops were completely served over, with a round thimble, seized, over the crown of the block.

The *snatch block* is a single sheave block, made in wood or metal. The wooden snatch block will have an internal binding but is rarely seen in practice, having given way to metal snatch blocks capable of taking a natural fibre rope.

Other types of wood block include solid turned clump, built clump, funnel block, and the double and triple sheave blocks used for lighter lifting operations.

Metal Blocks

The *single sheave cargo block* (Figure 4.20) finds a common use at the head and heel positions of the derrick. The difference between the two is that the head block will be fitted with an oval swivel eye, and the heel block will have the duck bill fitment, to prevent toppling when in the gooseneck and fouling the runner. The head block is often referred to as a gin block, but this is not strictly correct. Calling the head block a gin probably stems from the days of coaling ships, which regularly employed a gin as a head block.

There are many types on the commercial market, one of the most common being referred to as a 'Z' block. They may also be found in topping lift purchases or the lifting purchase of a derrick.

All metal cargo blocks are now stamped on the binding with the Safe Working Load and Certificate Number, together with the name of the manufacturer. The block usually contains a roller bearing sheave, fixed to rotate between the cheeks about a phosphor bronze bush. The bush is held in position by the square shaped axle pin. Sheaves are often of a self-lubrication design, having grease reservoirs cut into the bearing surface. The bush may also have a similar cut away for use as a grease cavity.

Double and treble sheave purchase blocks are of a similar construction to the single sheave, except that a partition plate separates the sheaves. They are used extensively for the heavier cargo work, being rigged in purchases for use as steam guys on direct heavy lifts. They are also in common use on 10 tonne SWL derricks, being incorporated in the lifting purchase.

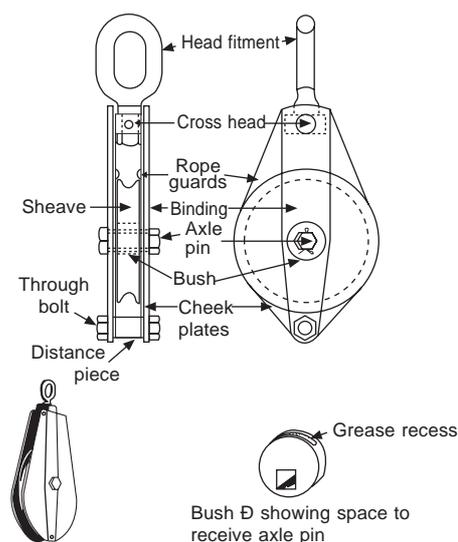


Figure 4.20 Metal block.

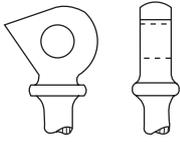


Figure 4.21 Duckbill eye.

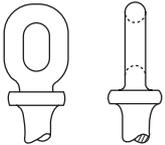


Figure 4.22 Oval eye.

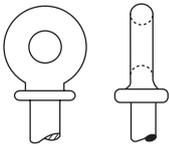


Figure 4.23 Round eye.

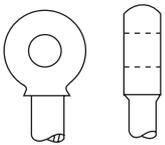


Figure 4.24 Stud eye.

The *multiple sheave cargo blocks* are used exclusively for heavy lift derricks, forming the lifting purchase. The number of sheaves will vary according to the design of the lifting apparatus; up to ten sheaves is not an uncommon sight when regular heavy lift work is being carried out. The following information relates to a 10-sheave block built for Costain John Brown Ltd:

Sheaves – Cast steel to take 27 mm diameter wire.

SWL of block – 102 tonnes.

Block tested to – 153 tonnes.

Weight of blocks (per pair) – $6\frac{1}{2}$ tonnes (approx.).

Block Head Fittings

Designed solely for fitting into the gooseneck of a derrick, the *duck bill eye* (Figure 4.21) is attached to the heel blocks of derricks to prevent the block from toppling and fouling the cargo runner.

Probably the most popular and most practical of all head block fittings, the *oval eye* (Figure 4.22) is used for all sizes of blocks from small wood blocks up to heavy lift blocks. The length of the oval allows easy access for shackles, together with freedom of movement and secure holding.

The *round eye* may have a swivel attached or just be used as a fixed ring, generally on the smaller wood blocks rather than the larger cargo blocks. See Figure 4.23.

A flat-sided fitment designed to accommodate supporting lugs either side, the *stud eye* (Figure 4.24) is in common use with the heavier type of cargo blocks.

Block head fittings for heavy lift gear are shown in Figure 4.7.

BLOCKS AND TACKLES

The term block and tackle, or purchase, as it is sometimes called, refers to the two blocks together with the wire or rope rove between them. It is a common mistake made by young seafarers and others to refer to just a block as a tackle or pulley. It should be clearly understood that the tackle is the combination of the cordage passing over a sheave contained within the block; a second block is suspended by the standing and running parts of the cordage.

The term tackle (pronounced taykle) is illustrated (Figure 4.25) to show the hauling part as a downhaul, coming from the standing block. Where the hauling part comes from the standing block as shown the purchase is said to be used to disadvantage. The opposite situation is to use a purchase to advantage, and Figure 4.26 shows the difference when the hauling part is led from the moving block as opposed to the standing block.

When we refer to advantage or disadvantage of a tackle, we are referring in both cases to the advantage that the purchase can give to the person carrying out the work. This may be more clearly understood if the purchase is assumed to be a simple and very basic machine which assists to move the work load.

The way the purchase is rove will affect the amount of effort that will be required to achieve the desired movement of the load.

Obviously, when any weight is lifted, either with a tackle or on a single part of rope, stresses in the cordage cause the weight to move. To this end it is possible to calculate the amount of stress in the hauling part from the formula:

$$S = \frac{W + \frac{N \times W}{10}}{P}$$

where S = Stress in hauling part
 N = Number of sheaves
 W = Weight being lifted
 P = Power gained by tackle

Examples of the use of this formula may be found on pp. 130–141.

Tackles – advantage and disadvantage (Figure 4.26). When a (double luff) tackle is used to advantage as illustrated, the hauling part is seen to be led from the floating or moving block. To calculate the power gained by using this tackle to advantage, a practical method can be applied by counting the moving parts of cordage, including the hauling part, which run between the blocks. In this example the power gained is 5. The same double luff tackle is now used to disadvantage, a more common method of use at sea. Note that the hauling part is seen to lead from the standing block. When calculating the power gained in this instance, exclude the hauling part. In this example the power gained is 4.

Gun Tackle

This is a tackle comprising two single sheave blocks, originally used aboard naval vessels for hauling the guns back into position after they had recoiled on firing, hence the name. The two blocks are each fitted with a hook attachment. Because of its historic background the gun tackle was generally used for hauling a load in a horizontal direction, but there is now no reason why the gun tackle should not be used in the vertical (Figure 4.25).

The power gained, or velocity ratio, by using this type of purchase will be either 2 or 3, depending on whether it is used to disadvantage or to advantage.

Handy Billy

This tackle is composed of a double sheave tail block and a single sheave hook block, rove together with a small fibre rope. The cordage should not be greater than 16 mm in circumference. The name 'Handy' comes from the tackle's light weight and transportability, and because the tail attached to the double sheave block allows easy securing in convenient positions.

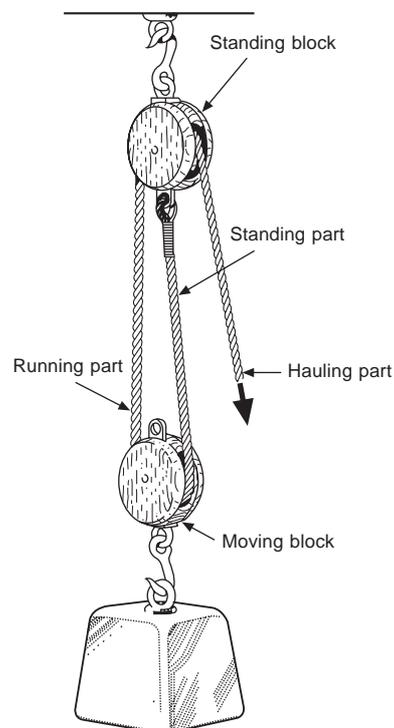


Figure 4.25 Gun tackle.

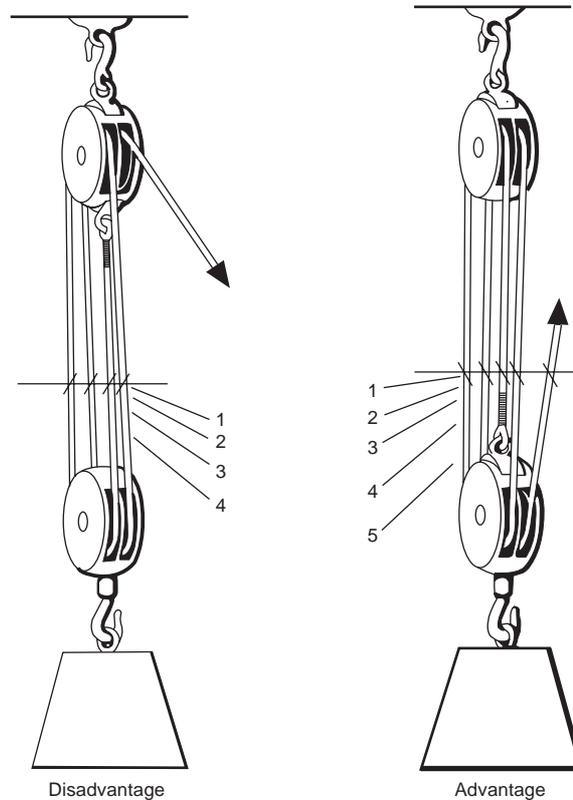


Figure 4.26 Tackles.

Jigger

This is a similar tackle to the Handy Billy, except that the cordage rove between the blocks is of a greater size, 20 mm in circumference, and the size of the blocks is increased accordingly. It is, therefore, a heavier duty tackle.

Luff Tackle

This is a purchase of similar construction to the Handy Billy, or jigger, regarding the number of sheaves. The main differences are that the double block has no tail – instead each block has a hook or swivel becket eye – and the cordage may be up to 24 mm in circumference or any size of wire. The power gained, will be either 3 or 4, depending on whether it is used to disadvantage or advantage (see Figure 4.27).

Double Luff Tackle

Composed of two double blocks, this tackle is often referred to as a double purchase. It is a general purpose tackle, having a velocity ratio of 4 or 5, depending on whether it is used to disadvantage or advantage (see Figures 4.26 and 4.28).

Gyn Tackle

This purchase (Figure 4.29) comprises a double and treble block, with a cordage or wire fall rove between them. The standing part is secured to the double block. The tackle produces a power gain of 6 or 5, depending on whether it is used to advantage or disadvantage.

Three-fold Purchase

A heavy duty tackle comprising two triple sheave blocks with a rope or wire fall rove between both blocks, this purchase is used extensively in heavy lift work for both topping lift and lifting purchase (see Figure 4.30).

There are two methods of reeving the three-fold purchase, one with the sheaves of both blocks in the same plane and the second, more popular, method with the plane of the sheaves in each block at right-angles to each other. The advantage of the latter, is that when the lift is made, the lower block hangs vertically without toppling over to one side.

Chain Blocks

There are several types of chain block in general use, the most common being (a) spur geared blocks, (b) lever and ratchet, and (c) wormwheel operation. They are often referred to as chain hoists, having a mechanical advantage of between 5 and 250. The lifting capability will be variable but their use for up to 40 tonnes is not uncommon practice. Although they are usually found operating from inside the machinery spaces of vessels, for numerous duties they may be employed on deck.

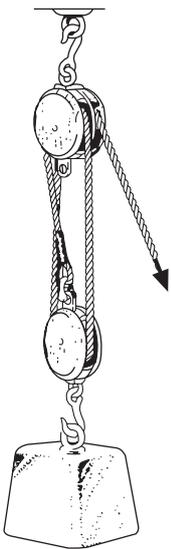


Figure 4.27 Luff tackle.



Figure 4.28 Double luff tackle.



Figure 4.29 Gyn tackle.

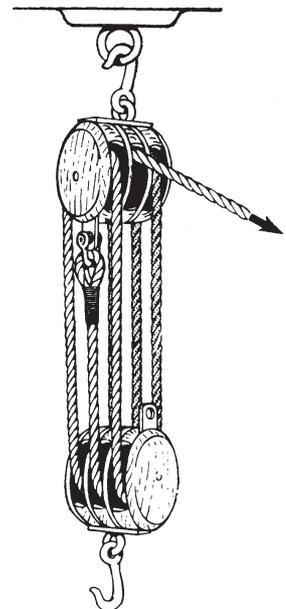


Figure 4.30 Three-fold purchase.

With spur geared blocks a manual drive chain turns a through spindle via geared cog wheels. A ratchet and pawl system is also incorporated so that the load may be held suspended from the load chain. This load chain is held by a sprocket arrangement which is being driven by the operation of the through spindle.

The lever and ratchet types, generally used for lighter work, are smaller and permit optional positioning wherever it is required. They are usually equipped with a reversible pawl system which allows its ratchet wheel to be turned in operation in either direction.

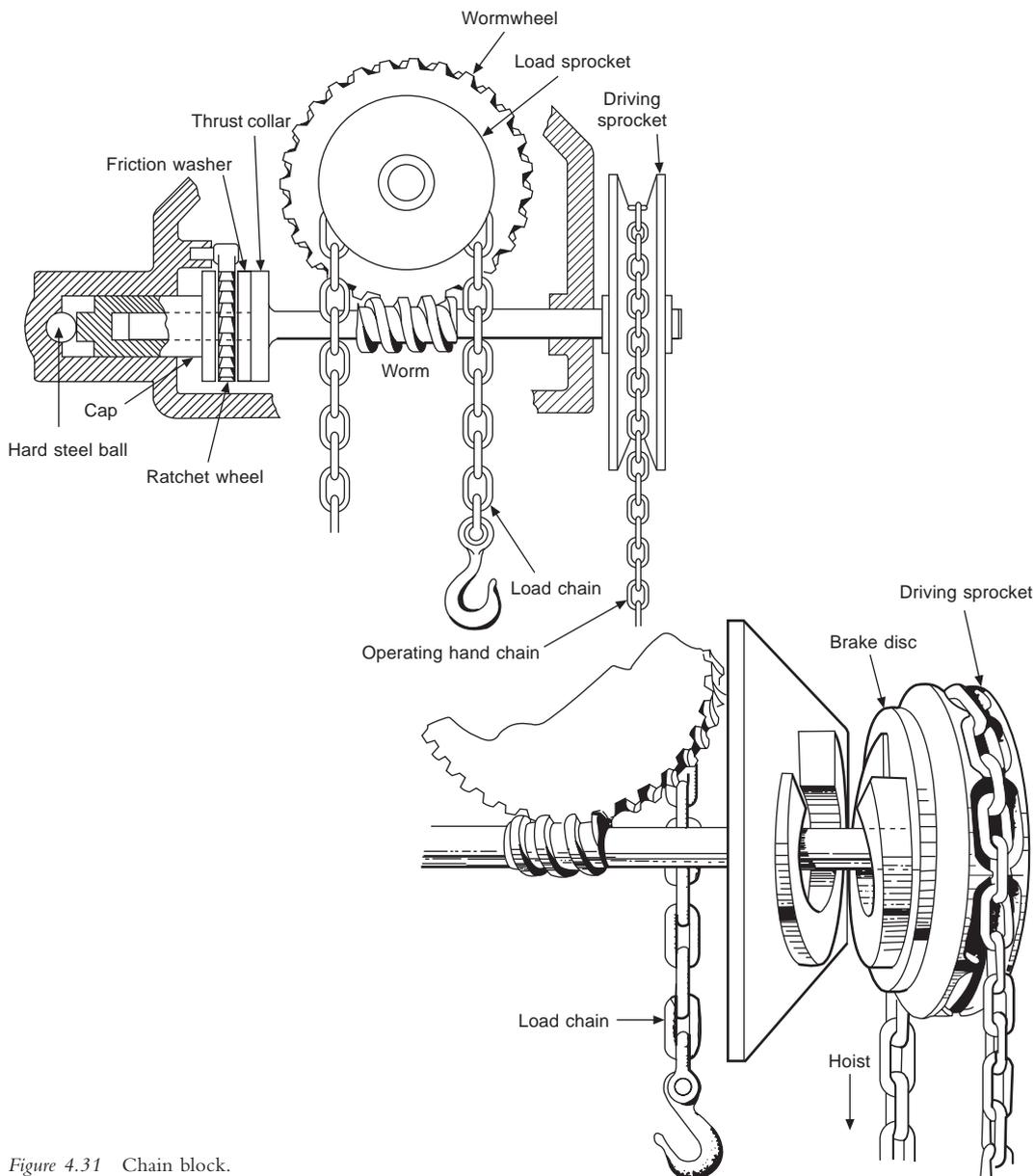


Figure 4.31 Chain block.

In wormwheel operation (Figure 4.31) an endless operating chain passes over a flywheel that causes an axle fitted with a worm screw to rotate. The worm screw engages with the helical teeth of a larger gear wheel, causing the load sprocket to turn and heave on the load chain. The load chain may be led through a floating block to increase the purchase effect of the machine or, as in Figure 4.31, be led direct from the load sprocket to the lifting hook. Nearly all these types of chain block incorporate a braking system that allows the weight being lifted to be suspended.

Weston's Differential Purchase

Let us find the mechanical advantage (see Figure 4.32).

Consider a load, W , being raised by the effort P .
Each of the chains A and B support $\frac{1}{2}W$ ($\frac{1}{2}$ weight)

Take moments about centre C. Let radii of large sheave be represented by R and small sheave by r .

$$\text{Then } \frac{1}{2}W \times CD = (P \times CF) + (\frac{1}{2}W \times CE)$$

By transposition of the above equation

$$P \times CF = (\frac{1}{2}W \times CD) - (\frac{1}{2}W \times CE)$$

Substitute radii R and r

$$PR = \frac{1}{2}W(CD - CE)$$

$$PR = \frac{1}{2}W(R - r)$$

Transpose

$$\frac{1}{2}W = \frac{PR}{(R - r)}$$

$$\frac{\frac{1}{2}W}{P} = \frac{R}{(R - r)}$$

$$\frac{W}{P} = \frac{2R}{(R - r)}$$

But $\frac{W}{P} = \frac{\text{Load}}{\text{Effort}} = \text{Mechanical advantage (MA)}$

$$\therefore \text{MA} = \frac{2R}{(R - r)}$$

Instead of radii R and r being used, the number of links which can be fitted round the circumference of the upper block sheaves may be substituted, as they are in proportion to the radii of the sheaves.

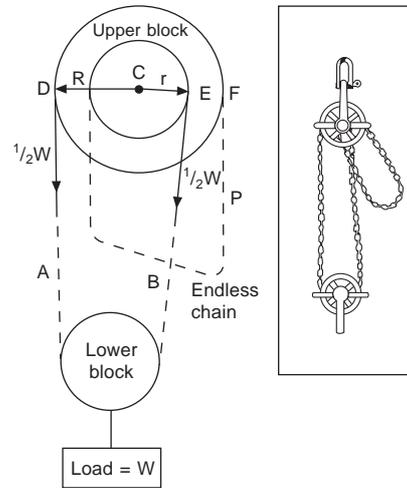


Figure 4.32 Weston's differential purchase. The upper block consists of two sheaves of different diameters, secured together. An endless chain (right) is rove between the upper and lower blocks. The links of the chain engage in the snug and under the rims of the sheaves, and cannot slip, so eliminating any frictional losses.

LIFTING GEAR



DERRICKS

The most widely used derricks in the marine industry are of a welded structure, consisting of either three or five welded sections of tubular steel. Wooden derricks, which generally lifted only up to 3 tonnes, have largely been superseded.

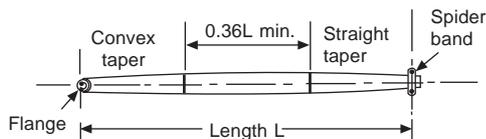


Figure 5.1 Derrick arrangement.

At the heel of the derrick (Figure 5.1) either a single flange or a double flange will be welded to permit attachment to the gooseneck, a through bolt passing between the gooseneck arrangement and the flange(s) of the derrick. This bolt, once secured, is guarded by a washer and split pin holding, or, in the case of heavy lift derricks, by shallow nut and split pin. The bolt is not subjected to lateral forces and the split-pin securing is generally an adequate method of retaining the bolt in position.

At the head of the derrick a spider band is fitted to permit the attachment of guys, topping lift and lifting purchase. This band is forged in one piece, the lugs not being allowed to be electrically welded to the band. Some heavy lift derricks have the spider band manufactured so that the lugs opposite each other are attached to a yoke piece that passes through the derrick, providing additional strength in working.

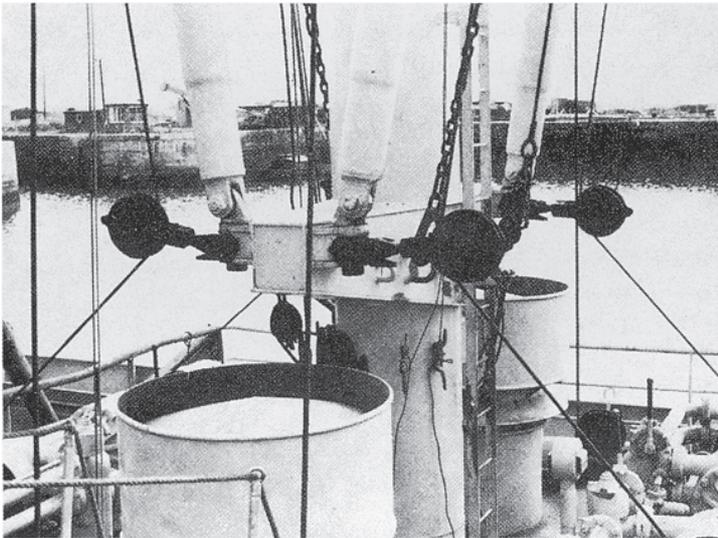
It is often the case when a derrick has a fairly considerable length, say 12 m or more, that derrick guides are fitted to prevent the cargo runner from sagging. These guides may take the form of a fixed hoop welded to the derrick, or they may be provided with a cast-iron roller. These rollers should be regularly maintained or they may cause undue chafe on the cargo runner wire.

Derrick gear is illustrated in Plate 11.

Single Swinging Derrick

The function of the derrick is to raise, transfer and lower weights. In the shipping industry this effectively means moving goods from the quay to the vessel or vice-versa.

The derrick boom is supported at the heel in a pivot arrangement



11. Gooseneck and derrick heel block arrangement.

known as the gooseneck, which allows elevation by means of a topping lift span. The topping lift may be of the nature of a single span or a purchase; either way the downhaul is led from the spider band of the derrick via the masthead span block (high upper support) to a convenient winch. Figure 5.2 shows a single span secured to a union plate, which also accommodates a chain preventer and a bull-rope. The bull-rope is a continuation of the downhaul for the purpose of topping or lowering the derrick.

The derrick is positioned to plumb the load by slewing the boom from port to starboard by means of a slewing guy secured on either side of the spider band. Slewing guys come in two parts, namely a cordage tackle (wire in the case of heavy lift derricks) secured to a wire guy pendant which is shackled at the derrick head.

The derrick may be equipped with a lifting purchase or a whip (single) cargo runner. In either case, once the derrick has been plumbed at the correct height for the load, the topping lift is secured, and the downhaul of the lifting purchase is led to the winch via the derrick heel block.

Many vessels are provided with dolly winches for the sole purpose of topping and lowering derricks. Dolly winches are usually fitted with a safety bar device and leave the main cargo winch to handle the lifting purchase or runner. Other types of dolly winch are operated from the main winch, in which case combined use of topping lift and lifting purchase is not possible, the dolly winch having to be disengaged to allow separate operations to be carried out.

When the derrick is rigged in the single swinging mode, the topping lift is secured and the actual height of the derrick does not change. However, the bull-rope may be replaced by a luff tackle, with the consequence that the topping lift effectively becomes the downhaul of

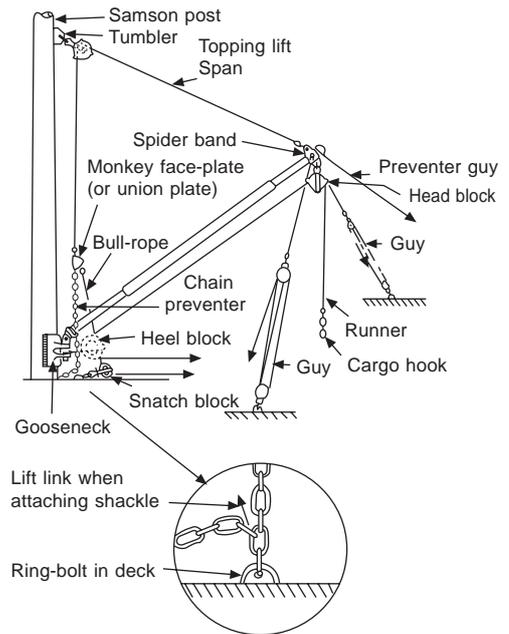
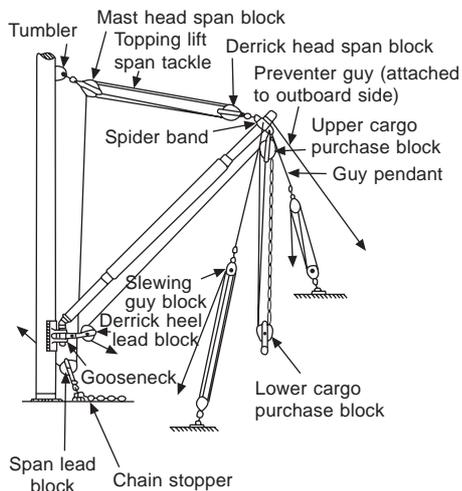


Figure 5.2 Single swinging derrick – single span topping lift chain preventer.

the luff tackle. If this is led to the winch direct, then the derrick is turned into a luffing derrick. With this method of rigging a second winch will be required to operate the cargo runner.

Topping a Single Span (Topping Lift) Derrick

1. Assume the derrick to be in the lowered position, secured in the crutch. Collect the chain preventer from its stored position, together with two tested shackles, a snatch block, seizing wire, marline spike and wire preventer if the derrick is to be rigged for union purchase.
2. Obtain power on deck and remove the cargo runner from the main barrel of the winch.
3. Secure the slewing guys to the spider band and stretch them to port and starboard.
4. Shackle the cargo working end of the runner to the deck, so as not to end up with the eye of the runner at the derrick head when topped.
5. Secure the bull-wire to the winch barrel (assuming no dolly winch system) via the snatch block.
6. Let go the derrick head lashing or crutch clamp, and man the guys.
7. Lift the derrick clear of the crutch (float the derrick) and pass the wire preventer over the derrick head, if for use with union purchase.
8. Heave on the winch, topping the derrick until the union plate (monkey face-plate) is down to the snatch block.
9. Shackle the chain preventer on to the union plate, mousing the shackle.
10. Come back on the winch, lowering the derrick to the required height. Secure the chain preventer when the derrick reaches the desired working height. When shackling the chain preventer to the deck lug bolt, ensure that the shackle is clear of the next link of the preventer, so as not to foul and cause the rig to jump when under load. Mouse the shackle.
11. Remove the bull-rope from the winch and secure hand tight about the mast cleats. This bull-rope will now provide a back-up to the chain preventer.
12. Secure guys once the derrick is slewed to the desired position.
13. Secure the cargo runner once more to the main barrel of the winch.

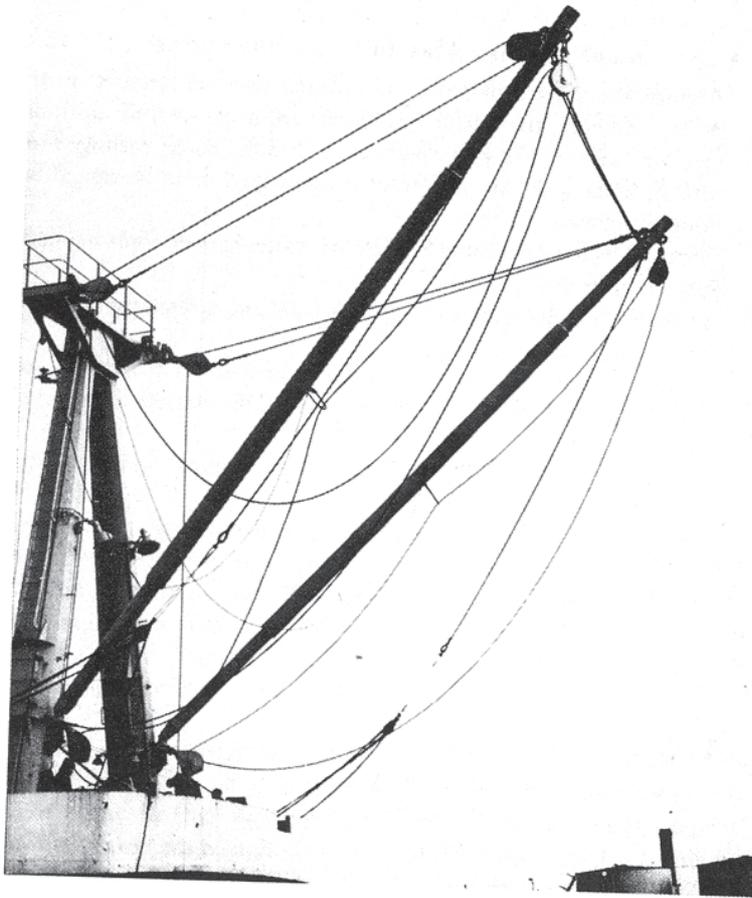


⊙Preventer guy only rigged when the derrick is to be worked in union purchase⊙

Figure 5.3 Single swinging derrick – topping lift span tackle.

Topping a Derrick – Topping Lift Span Tackle

1. Assume the derrick (Figure 5.3) to be in the lowered position, secured in the crutch. Obtain lead block, chain stopper, marline spike, rope yarns and wire preventer guy if the derrick is to be used in union purchase rig.
2. Obtain power on deck and remove the cargo runner from the barrel of winch.
3. Secure slewing guys to the spider band and stretch them to port and starboard.



12. Two 10-tonne derricks rigged in union purchase employing a schooner guy between the spider bands, and topped together.

4. Shackle the cargo working end of the runner to the deck, so as not to end up with the eye of the runner at the derrick head when topped.
5. Take the weight of the topping lift downhaul by passing a chain stopper round it. Lead the downhaul of the topping lift via a lead block on to the main barrel of the winch. Take the weight of the wire on the winch and remove the chain stopper.
6. Remove the derrick head lashing or crutch clamp, and man the guys.
7. Lift the derrick clear of the crutch and pass the wire preventer over the derrick head for use with union purchase.
8. Top the derrick up to the desired working height, by heaving on the topping lift downhaul.
9. Pass the chain stopper on the topping lift downhaul once the derrick is at the required working height and the winch is stopped.
10. Ease back on the winch until the weight comes on to the chain stopper.
11. Remove the topping lift downhaul from the winch and secure it

hand tight about the mast cleats. This operation should be carried out while the weight is on the chain stopper. Once completed, the stopper can be removed. When turning the wire up on to the mast cleats, make three complete turns before adding the four cross turns, the whole being secured with a light rope yarn lashing.

12. Provided a lead block is used for the downhaul of the topping lift, and not a snatch block, there is not the need to remove the block from the way of the wire.
13. Secure slewing guys once the derrick is plumbed correctly, and also the cargo runner to main barrel of winch.

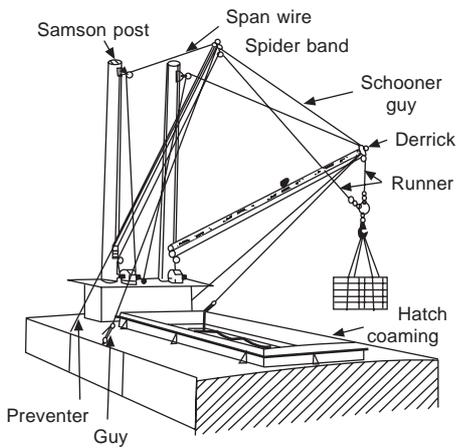


Figure 5.4 Union purchase rigged with schooner guy. For clarity, guardrails etc. have been omitted.

UNION PURCHASE

This is by far the most popular rig using two derricks (see Plate 12). It is a fast efficient method of loading or discharging cargo. The derrick may be used in a single swinging mode when not employed in a union purchase rig, so providing versatile cargo handling over a considerable range of cargo weights.

The rigging of the union purchase rig (Figure 5.4) is arranged by plumbing the inshore derrick over the quayside, while the second derrick is plumbed over the hatch area containing the cargo. The two cargo runners are joined together at a triple swivel hook, known as a union hook, or often referred to as a Seattle hook (Figure 5.5). The two derricks are held in position by slewing guys, which, once the derricks are plumbed correctly, are secured, so that the derricks will not be allowed to move. The operation is carried out by the weight of the load being taken by one derrick and transferred via the cargo runners to the second derrick (Figure 5.5). It should be noted that the derricks do not move throughout the whole operation. The only moving parts are the two cargo runners led to winches.

The stresses that come into play when working this rig are considerable because of the angles made with the cargo runners, and as a rough guide one-third of the safe working load of the derricks may be taken as a working weight, e.g. 5 tonnes SWL of derricks, then 1.6 tonnes may be considered the SWL of the union purchase rig.

Union purchase rig has several variations, the main one being in the distribution and position of guys (Figures 5.4 and 5.5). An advantage with the schooner guy is that there is a saving of cordage, as only three guys are used to secure the rig, while with crossed inboard guys the total is four slewing guys.

When rigging derricks for union purchase rig, each derrick should be topped in the normal manner (see p. 108). The exception to this is when the schooner guy is fitted: then both derricks should be topped together, with the tension being kept on the schooner guy to prevent them splaying apart as they rise. For the operation of topping derricks with the schooner guy, more manpower is obviously required to top both derricks at once.

Preventer guys, not to be confused with slewing guys, should be

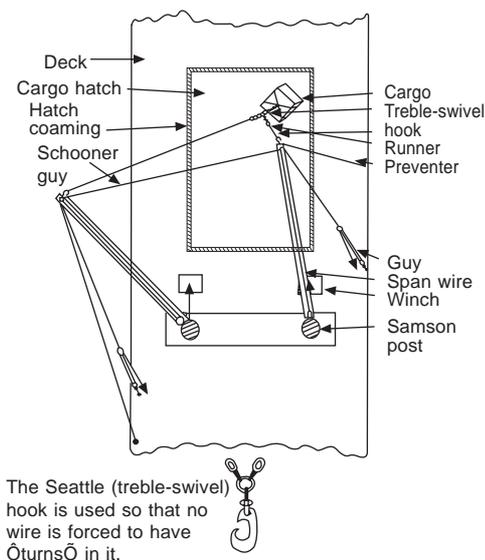


Figure 5.5 Union purchase rig (plan view).

passed over the derrick heads once the derricks have been floated from their crutches.

Preventer Guys

Preventer guys are to be fitted in addition to slewing guys, and their safe working load should not be less than that indicated in Table 5.1 or as found by parallelogram of forces of the rig, whichever is the greater.

TABLE 5.1 Safe working load

<i>SWL of derrick rig (tonnes)</i>	<i>Required SWL of each slewing guy (tonnes)</i>
1	1
2	1 ¹ / ₂
3	2
4	2 ¹ / ₂
5	3
6	3 ¹ / ₄
7 to 9 ¹ / ₂	3 ¹ / ₂
10 to 12 ¹ / ₂	3 ³ / ₄
13 to 15	4
16 to 60	25% of SWL of derrick rig
61 to 75	15
more than 75	20% of SWL of derrick rig

The above table may be considered a guide only when vessels are at suitable angles of heel and trim. Under certain conditions, when additional slewing guys are attached to the lower cargo purchase block, a permitted reduction in safe working loads of guys is tolerated.

Preventers should be made of wire rope, or wire and chain construction, and attached to the derrick separately from the slewing guys. Deck eye plates should be so positioned so as to prevent excessive guy tension building up, while keeping the working area clear for the passage of cargo slings. Preventers should be secured by use of shackles through the chain link to the eye plate on the deck, or if all wire preventers are being used, then securing is often obtained by 'ferrules' fused on to the wire at regular intervals and held by a pear link arrangement.

The preventer should be rigged with an equal tension to that of the slewing guys on the outboard side of both derricks. Should the rig become over-strained in any way, then the slewing guy will be allowed to stretch, being cordage, whereas the preventer will bear the weight and not give, being of wire or chain construction. An even tension on preventer and outboard guy is attained by securing both these guys first, and then taking the weight on the inboard guy of each derrick in turn.

Slewing Guys

Slewing guys are generally constructed in two parts: a guy pennant of steel wire rope shackled to a cordage tackle. This provides a limited

amount of elasticity, allowing the guy to stretch and avoid parting under normal working conditions.

Table 5.1 is a guide to the safe working load of guys in respect of safe working loads of derrick rigs. When rigging derricks in union purchase, slewing guys, and preventer guys should never be secured to the same deck eye bolt but to separate anchor points.

SAFE HANDLING PRACTICE FOR DERRICKS

1. All derrick rigging should be regularly maintained under a planned maintenance programme, and in any event should be visually checked for any defect before use.
2. Before a derrick is to be raised, lowered or adjusted with a topping lift span tackle, the hauling part of the topping lift should be flaked down the deck clear of the operational area. All persons should be forewarned of the operation, and to stand clear of the bights of the wire.
3. When topping lifts are secured to cleats, bitts or stag horns, three complete turns should be taken before the additional four cross turns on top. A light lashing should be placed about the whole to prevent the natural springiness of the wire causing it to jump adrift.
4. When the rig of a derrick is to be changed or altered in any way, as with doubling up, then the derrick head should be lowered to the crutch or to deck level in order to carry out alterations safely.
5. When dolly winches fitted with a pawl bar are employed, the pawl should be lifted to allow the derricks to be lowered. Any seaman designated to carry out this task should be able to give his full attention to the job and be ready to release the bar should anything untoward happen in the course of the operation. Under no circumstances should the pawl bar be wedged or lashed back.
6. Winch drivers should take instructions from a single controller, who should pass orders from a place of safety from which a clear and complete view of the operation must be available. When derricks are being raised or lowered, winch drivers should operate winches at a speed consistent with the safe handling of the guys.
7. Cargo runners should be secured to winch barrels by use of a 'U' bolt or proper clamp, and when fully extended, a minimum of three turns should remain on the barrel of the winch.
8. Should it be necessary to drag heavy cargo from 'tween decks the runner should be used direct from the heel block via snatch blocks to avoid placing undue overload on the derrick boom.

Safe Handling Reminders for Union Purchase Rig

1. To avoid excessive tension in the rig the safe working angle between the married cargo runners should not normally exceed 90°, and an angle of 120° should never be exceeded.
2. The cargo sling should be kept as short as is practicable to enable the cargo to clear the hatch coaming without extending the safe working angle between the cargo runners.

3. Derricks should be topped as high as practicable, and not rigged farther apart than is absolutely necessary.
4. Derricks should be marked with the safe working load when rigged for union purchase. Should this not be the case, then the safe working load should not be more than one-third the SWL of the derrick itself.
5. Preventer guys of adequate strength should be rigged on the outboard side of each derrick, and secured to the deck in the same line and with similar tension as the slewing guy. However, they must be secured to separate pad eyes to the eyes which accommodate the slewing guys.

DOUBLING-UP PROCEDURE

The cargo runner of a derrick may be doubled up when it is desired to make a lift which the rig is capable of handling safely but which exceeds the SWL of the cargo runner when rigged as a single whip (see Figure 5.6).

Some derricks are equipped with a second doubling-up spider band but this is not the case with every derrick. Obviously the doubling of the runner, making a double whip, is made very easy when the second spider band is fitted. The eye of the runner is shackled to the second band, leaving a bight between the head block and the shackled eye. A floating block is secured in the bight, effectively making the arrangement into a 'gun tackle'.

Should the derrick not have the convenient second spider band, then it will be necessary to parcel the derrick with canvas and take a half hitch with the runner around the derrick, taking the eye of the runner and securing it to the lug on the spider band that accommodates the topping lift. This effectively produces a similar bight in the wire for the floating block as previously described.

When doubling up in this manner it will be appreciated that a snatch block used in the bight would be much simpler to rig, but it would not be as safe as an ordinary cargo block. This will necessitate the reeving of the block before completing the half hitch about the derrick.

The half hitch is prevented from riding down the derrick by the retaining shackle to the spider band and also by the wire biting into the parcelling that affords the derrick some protection. Once the load is off the cargo hook, the tension in the half hitch is relieved, but, owing to the weight of the wire and the floating block, it would be unlikely for the hitch to slip against the natural forces of gravity.

BUTTERFLY RIG

This rig is very similar to union purchase, except that derricks from adjacent hatches are used, whereas with the union purchase rig, derricks from an individual hatch are used. The advantage of this rig is that it often enables a maximum number of stevedore gangs to be engaged by combining both butterfly and union purchase rigs throughout the vessel.

As indicated in Figure 5.7, the vessel is loading/discharging into barges. Table 5.2 shows how this is done.

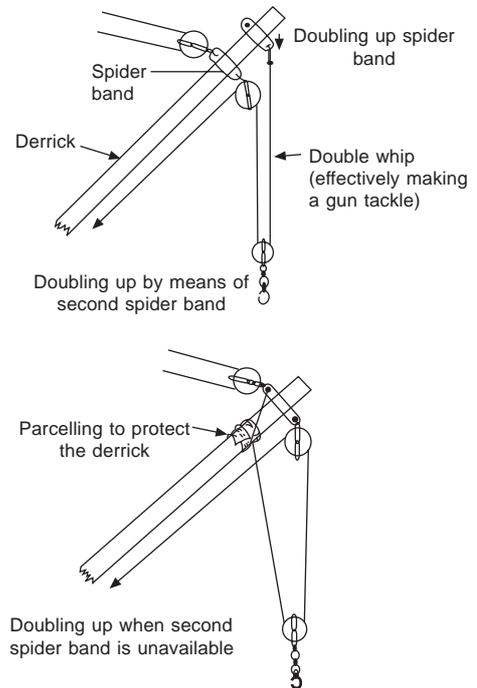


Figure 5.6 Doubling up a derrick.

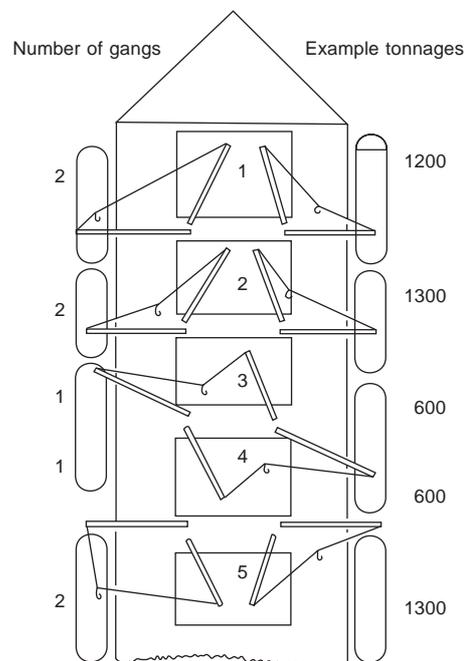


Figure 5.7 Butterfly rig.

TABLE 5.2 Loading and discharging using different rigs

Hatch no.	Gangs employed	Type of rig
1	2	Butterfly
2	2	Butterfly
3	1	Union purchase
4	1	Union purchase
5	2	Butterfly

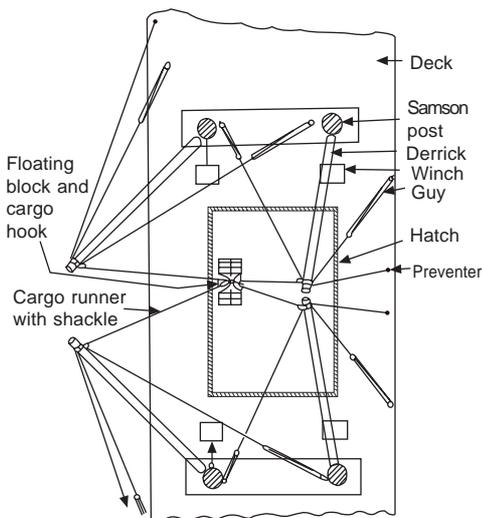


Figure 5.8 Yo-yo rigged with four derricks.

The rig can prove useful when the distribution of cargo is such that all hatches must be kept working so as to complete cargo operations at approximately the same time. It is not a common method of rigging, however, and often has the disadvantage that ventilators and masts etc. impede the area of pluming the derrick.

YO-YO RIG

This rig is sometimes referred to as a block in bight rig, and may be employed with two or four derricks. The purpose of the rig is to allow the loading or discharge of heavier loads than those which can be handled by the more popular union purchase rig or by a single swinging derrick.

With Four Derricks

This is probably the most popular of the two yo-yo methods (Figure 5.8). The derricks once rigged for union purchase do not have to be adjusted. The two cargo runners of the inboard derricks are passed through a floating block, and the two outboard derrick runners are passed through a second one. The separate pairs of runners are shackled together, as are the floating blocks, to form the union, the cargo hook being secured under the floating blocks.

The lifting operation can be started once the guys have been tightened up. The winch operators should be warned beforehand that, with the runners being shackled together, the joining shackles may run foul of the derrick head block or the floating block in the bight of the runners. An experienced winchman will identify the limits of the wire runner by marking the wire to indicate the extent the runner may be paid out or heaved in without fouling the blocks.

With Two Derricks

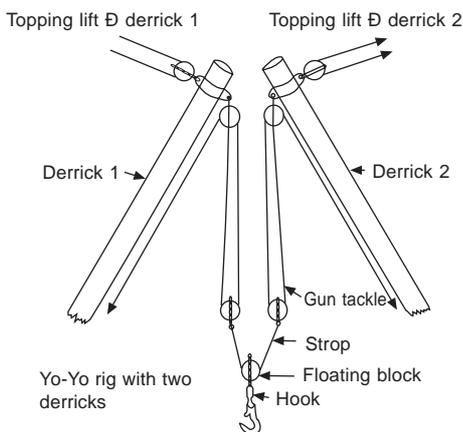


Figure 5.9 Yo-yo rigged with two derricks.

This rig uses the two inshore derricks. Each derrick in Figure 5.9 has been rigged with a gun tackle, and the moving blocks have been joined by a heavy strop supporting a floating block with cargo hook attached. The operation of loading or discharge is carried out by slewing both derricks towards the quayside, trying to keep both the derrick heads as close together as is practicable.

The advantage of the floating block with the strop is that, should the

rig suffer a winch failure, the full weight of the load will not come to bear on one derrick.

HALLEN UNIVERSAL DERRICK

This probably represents one of the most successful advances in lifting gear over the last twenty years. The many advantages of this type of derrick make it a very popular choice with the shipowners (see Figure 5.10).

The derrick is labour saving, as it can be operated by one man. The lifting capacity may be up to 200 tonnes, through a working radius of 170° , being topped up to 85° . It is an extremely stable rig, being supported by either a straight mast or a 'Y' style mast. Stabilising outriggers provide superior leads for the slewing operation over the greater working area. These outriggers, a recent innovation, have almost completely superseded the 'D' frame design of the early 1960s.

The complete operation of the derrick rig is handled by one man positioned at a control console. A joystick control allows topping and lowering, together with slewing to port and starboard, and a second lever operates the lifting purchase hoist. The guys of the conventional derrick design have virtually been eliminated in this design. The topping lifts have a double function of slewing the derrick as well as controlling the elevation. The topping lift wires take up to 75 per cent of the load and so provide greater safety aloft.

The whole design and operation may be compared to that of a crane inclusive of built-in limit switches that prevent overslew and overtopping. Variations in the reeving of the topping lifts have occurred since the 'D'

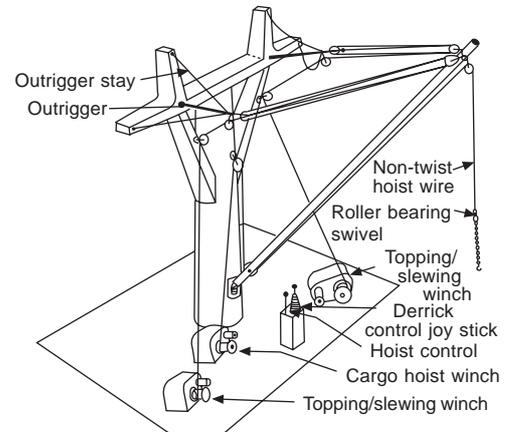


Figure 5.10 Hallen universal swinging derrick.

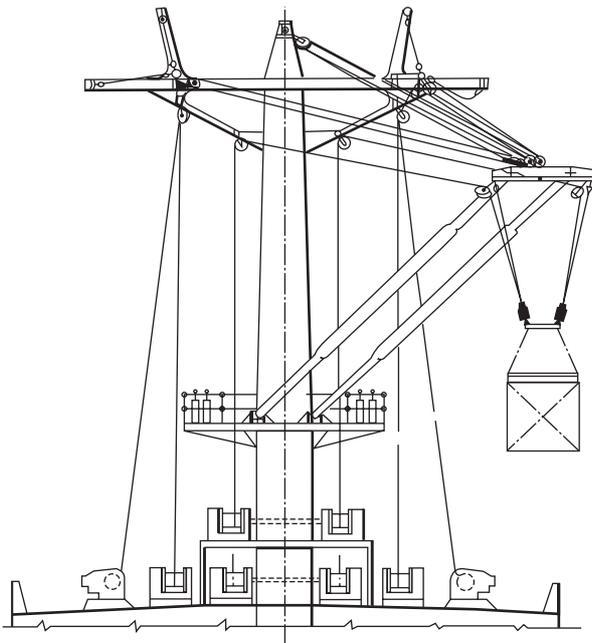


Figure 5.11 Hallen container derrick.

frame type, the slew tackles having been replaced by an endless fall rove to function as a conventional topping lift.

HALLEN CONTAINER DERRICK

This container derrick (Figure 5.11) consists of two parallel derricks connected by a top beam that is flexible to the derricks themselves. This beam is always perpendicular to the line of the derricks, allowing the container cargo to be held and transported from the quay in a maintained position, irrespective of the derrick positions. The beam supports two cargo tackles, which may in turn support an automatic grabbing arrangement for containers.

Should the derrick be required for loading light or heavy general cargo, then the cargo tackles may be replaced by single cargo runners. The rig may also be employed as a single swinging derrick using a single runner rove through a single sheave block secured to the centre of the top beam.

The container derrick is operated in a similar manner to that of the Hallen universal derrick, in that one man controls the operation. It has good stability, operating over 180° radius, and being topped up to approximately 85°.

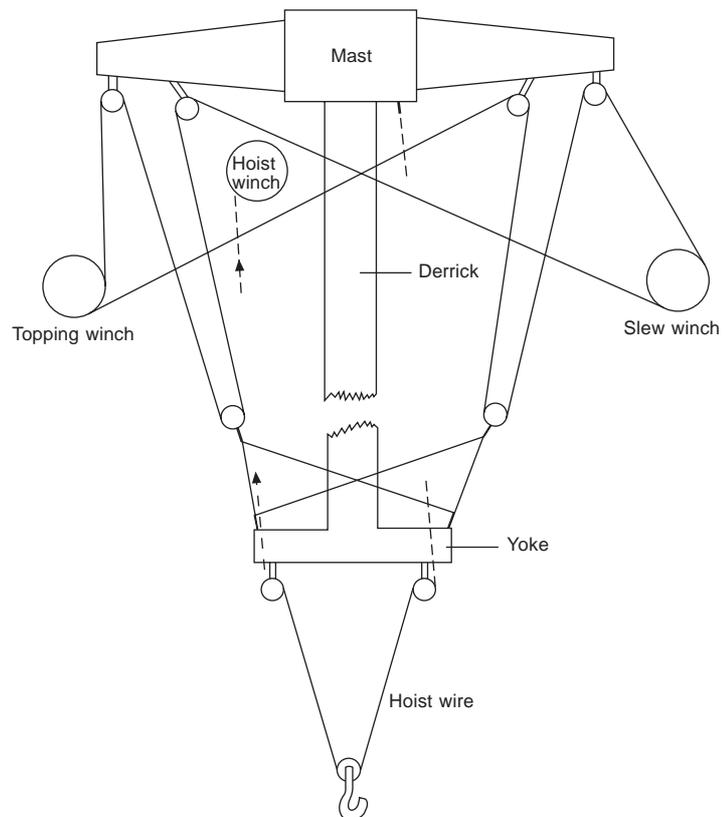
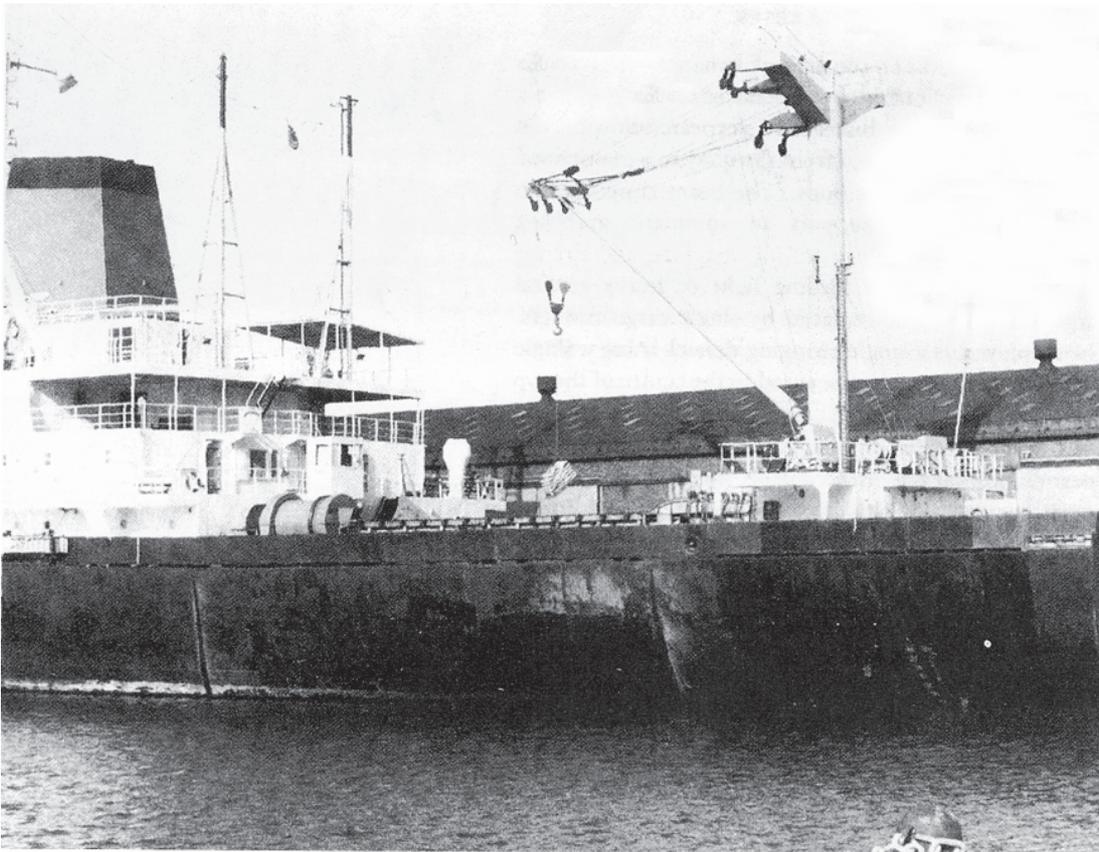


Figure 5.12 Velle shipshape crane.

VELLE SHIPSHAPE CRANE

This is a derrick system (Figure 5.12) which has become increasingly popular over the last decade. The boom is fitted with a 'T' shaped yoke at its extremity for the purpose of fitting four short steel wire 'hangers'. This bridle arrangement allows very wide slewing angles because the topping lift falls act to aid recovery when the derrick is slewed outboard. The yoke also provides the securing points for the two hoist wire leading blocks. The separation between the leading blocks allows a sympathetic motion between the load on the hook and the derrick head and so reduces pendulous swinging of the load.

Luffing and slewing motions of the rig are controlled by two winches each equipped with divided barrels. The luffing winch accommodates the fall wires, being turned up on to the barrels in the same direction, so allowing both to lengthen or shorten as desired, while the wires on the slewing winch are turned up in opposite directions. As rotation occurs one fall shortens while the other pays out, so slewing the derrick to port or starboard.



13. Velle crane in operation.

The advantages of this type of rig are that cargo-handling speed can be increased, since the derrick can engage in luffing and slewing operations at the same time while under full load. It has also been shown to be a very stable rig in operation, being controlled by a single operator using a joystick lever control similar to the Hallen derrick.

HEAVY LIFT PROCEDURES

Before beginning a heavy lift operation the officer in charge should make sure that the lift can be carried out in a safe and successful manner. Depending on the load to be lifted, the vessel can be expected to heel over once the lift moves off the fore and aft line. Therefore, heads of departments should be given ample warning of an expected list, before the operation begins.

The ship's gangway should be lifted clear of the quayside, and all fore and aft moorings tended, to ensure no damage is incurred by the heeling angle of the vessel. The critical times are when the load is overside and the vessel is at maximum angle of heel, and once the load is landed and the vessel returns to the upright position.

The vessel's stability should be thoroughly checked before starting the operation, with particular regard to free surface in tanks. When the lift is taken up the derrick, the rise in the ship's centre of gravity should be such that she is not rendered unstable. (The effective C of G of the load acts from the derrick head position above the centre of gravity of the ship once the load is lifted.)

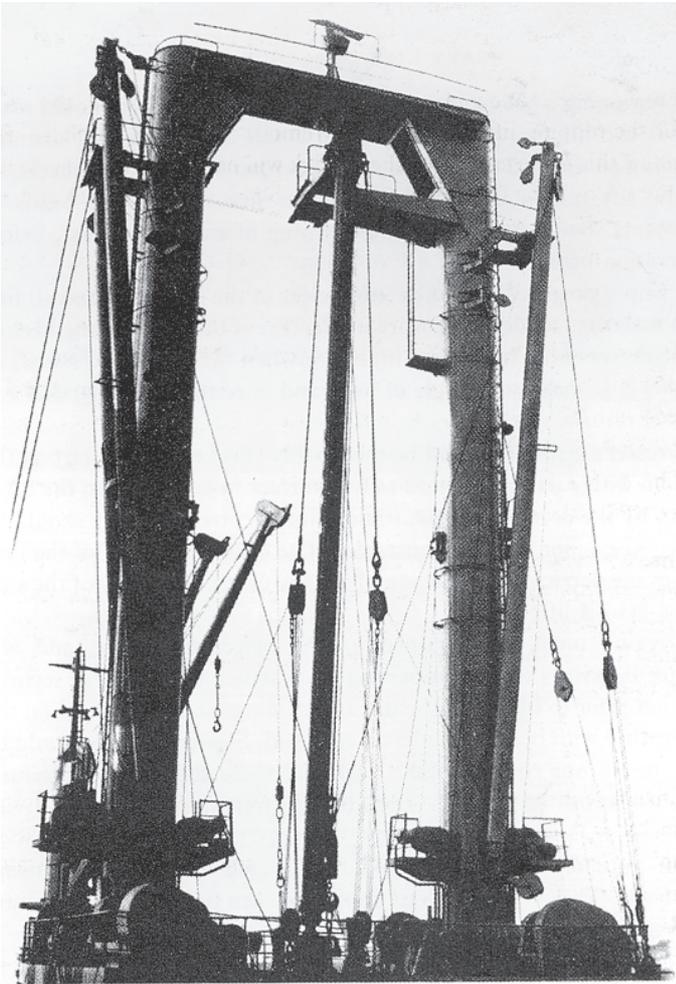
All rigging must be examined by the officer in charge, and any preventer backstays to the supporting mast structure should be secured in position prior to lifting the load. Correct slings should be used on the load, together with beam spreaders if required. Steadying lines should be secured to all four corners of the load, and these should be substantial enough to control oscillations when lifting from ship to quay and vice-versa.

Steam guys or power guys should be rigged and tested to ensure correct leads. The lifting purchase should be seen to be overhauling, and winches should all be in double gear.

The lugs on the load itself should be checked before securing slings to ensure that they are adequate to handle the load stress. Extreme care should be taken with crated heavy objects. Shippers are known to crate loads without reinforcing the crate itself, and the possibility of having the load fall from the bottom of the crate is a real one.

Landing the load on to a truck or flat top rail car may cause lateral drag on the vehicle as the weight comes off the derrick; and the vessel may return sharply to the upright position, accentuating this effect. To alleviate the situation, the offshore guy could be eased out as the load lands and the lifting purchase should be veered smartly. It is essential that competent winch drivers are operating the lifting purchase and the guys, and that throughout the operation they are under the control of a single person.

A heavy lift derrick is shown in Plate 14.



14. Heavy lift derrick shown in the stowed (vertical) position, with supporting samson post (goalpost) arrangement accommodating smaller derricks for general purpose cargo operations.

Rigging of a Heavy Lift (Jumbo) Derrick

This operation is generally carried out with the derrick (Figure 5.13) in the vertical position while clamped against the mast. Special lugs are secured to the mast to facilitate the raising of the topping lift blocks to the required positions. The topping lift is often left in the reeved condition, in place between the derrick and the mast, and in this case the rigging is usually protected by a canvas covering.

Rigging should proceed as follows:

1. Check that the vessel is in the upright position on an even keel.
2. Clear away any other rigging, such as smaller derricks or radio aerials, which may be in the way of operation.
3. Clear away any canvas protective covers.
4. Rig preventer backstays to the mast if required.
5. Ensure the topping lift is in good condition, securely shackled in position.

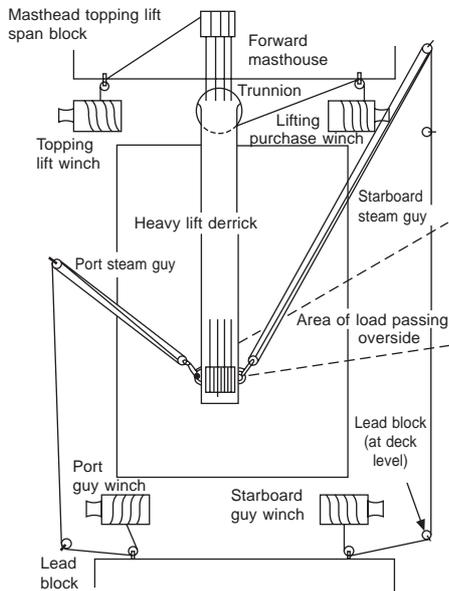


Figure 5.13 Heavy lift jumbo derrick (plan view).

6. Engage two winches for the port and starboard power guys (steam guys). Check that the leads from the winches to the derrick head are clear of all bad nips and that the moving blocks will not foul deck equipment.
7. Engage two other winches, one for the lifting purchase, the other for the topping lift. Many vessels remove the lifting purchase after use; if this is the case, then the derrick will have to be lowered to just above hatch level to allow the head block to be secured and the reeving of the tackle to take place.
8. Send a man aloft to pass a wire messenger about the derrick head and to remove the clamp holding the derrick to the mast.
9. Once the clamp has been removed, the weight should be taken on the messenger to break out the derrick. The derrick should be lowered to a point where the lifting purchase can be conveniently secured. As the derrick is broken out and in the process of being lowered, the topping lift should be seen to be overhauling.
10. Check that all winches are in double gear and that all rigging is secure before commencing the lift.

The time for rigging the derrick will vary with the experience of crew members, but one to two hours should be allowed for. The movements of the derrick under load are by necessity slow, to reduce stress. When operating, due regard should be taken of the weight of the slings, which may be in excess of 3 tonnes.

Precautions

1. Ensure that the stability of the vessel is adequate and the maximum heel acceptable. Remove free surfaces where practicable by 'pressing up' or emptying tanks (large GM – small heel). (GM stands for Initial transverse *metacentric height*.)
2. Rig extra mast stays as necessary.
3. Carefully check condition of derrick and gear before use. Ensure free rotation of sheaves. Oil and grease as necessary. Ensure SWL of all gear is adequate and that appropriate valid test certificates are in Register of ships lifting appliances and cargo handling gear. (When checking SWL, allow for weight of purchase and other lifting gear.) After breaking out derrick, check for free rotation and slewing about gooseneck.
4. Rig fenders as necessary.
5. Ensure all moorings are taut and have men standing by to tend as necessary.
6. Put winches in double gear.
7. Clear area of deck where weight is to be landed of all obstructions and lay heavy dunnage (bearers) to spread load. Secure or jam bearers in position.
8. Check ship's data to ensure deck is strong enough to support load. If in doubt, shore up from 'tween deck.
9. Clear area of all but essential personnel.
10. Ensure winch drivers are competent and fully aware of who is to give directions.

11. Secure steadying lines to corners of load.
12. Remove rails if possible.
13. Cast off any barges alongside.
14. Before lift begins inform all relevant personnel, e.g. engineers, cooks and stevedores working other holds.
15. Raise gangway before lift commences.
16. Use lifting points – otherwise sling it, using dunnage for sharp corners. If possible, use long strops to avoid them pulling together.
17. Set tight steam guys before lifting (set about 30° to horizontal, making a good angle with derrick head). Consider attaching guys to floating block.
18. When all is ready, take weight slowly then stop and inspect all round before lifting further. If all is in order proceed with caution.

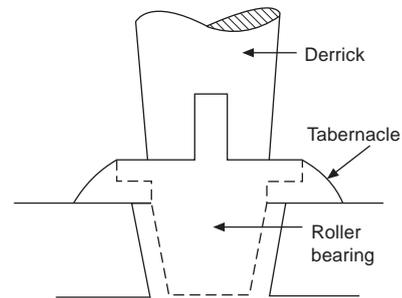


Figure 5.14 Stulcken derrick. The heel is set on a tabernacle that has a roller bearing for derrick movement.

Stulcken Derrick

This is a heavy lift rig (Figures 5.14 to 5.16) fitted to well over 200 merchant vessels. There are several variations but the design is largely one of a heavy derrick supported by two inclined masts (inclined in the outboard direction). It is operated by four winches, two of which work the topping lift falls. The main advantages of the rig are its great lifting capacity (up to 320 tonnes SWL), its fast cargo handling, and its ability to operate at two separate hatches.

The rig is equipped with over 100 anti-friction bearings, which produce only about 2 per cent friction throughout a lifting operation. These bearings do not require maintenance for up to four years, and, with the fact that deck gear is reduced with this rig, the reduced maintenance programme becomes a welcome relief to ships' operators.

Design features include the four heavy duty winches, arranged in pairs inside the supporting mast posts. The winches, one above the other, have two gear ratios, which allow operation of half load at twice the full load hook speed. Safety switches are incorporated with each winch to prevent any irregularities when lifting, the topping and slewing of the derrick being handled by one pair of winches while the other pair operate the cargo lifting purchases.

The standard wire for the rig will be 40 mm, and the barrels of the winches are generally spiral grooved to safeguard the wire ropes for the first layer of turns. The length of span tackle will be a variable on the length of the derrick and the radius of operation.

CRANES

The crane, although a standard piece of port or harbour equipment, has been incorporated aboard the modern cargo vessel with successful results. Not only is the crane a labour-saving device (only one driver per crane) but the manoeuvrability of the cargo hoist is much greater than that of a derrick (see Plate 15).

Most shipboard cranes may be fitted to swing through 360° but, for the purpose of safe handling, limit switches often act as cut-outs to stop the jib of the crane fouling obstructions. Limit switches are also fitted to

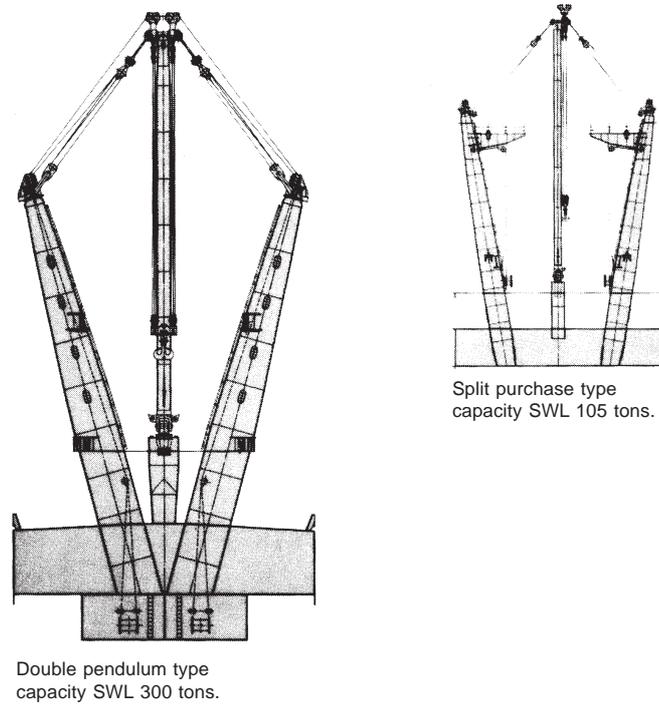


Figure 5.15 Stulcken masts, for heavy lifting operations.

Both types are manufactured by Blohm and Voss. Each system may be fitted with mast cranes or light derricks for the handling of smaller cargo.

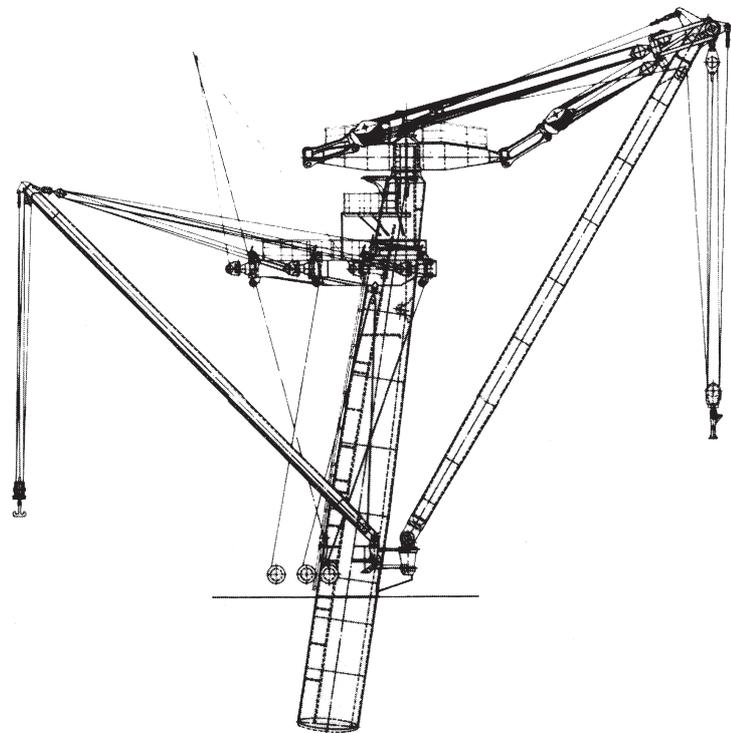
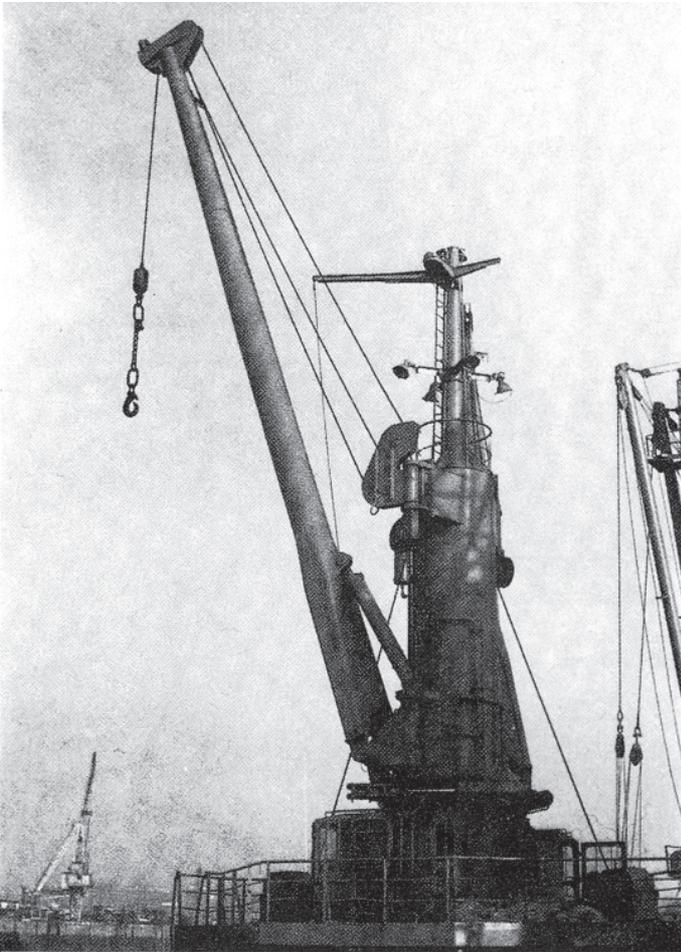


Figure 5.16 Stulcken mast – pivot type.
 Capacity SWL 250 tons.
 Length of derrick 30 m.
 Outreach up to 14.15 m.
 Operation with up to 5° list and/or -2° trim.



15. Deck crane with safe working load of 10 tonnes.

the luffing operation of the jib, as well as the cargo hoist wire, to prevent offsetting of the jib-boom, and the cargo hook fouling the upper sheave(s) of the hoist.

All cranes are provided with individual motors to permit luffing, slewing and cargo hoist operation. They can operate against an adverse list of approximately 5° together with a trim of 2° . Twin cranes may operate independently or be synchronised to work under one driver from a master cabin.

The seafarer should be aware that there are many types of crane on the commercial market and their designs vary with customer requirements. As a general rule cranes conform to the following design:

Machinery platform. Accommodates the DC generator; gearboxes for luff, slew and hoist operations; the slewing ring; and the jib foot pins.

Driver's cabin. Integral with the crane structure. Welded steel construction with perspex windows. Front windows to open. Internal lighting.

Jib. Of welded steel construction. Supporting upper sheaves for topping lift and cargo hoist.

Sheaves. Mounted in friction-resistant bearings.

Topping lift and hoist. Galvanised steel wire ropes having a minimum breaking strain of 180 kgf/mm². Depending on the SWL of the crane, this breaking strain could be greatly increased.

CRANES AND DERRICKS – ADVANTAGES AND DISADVANTAGES

Cranes. Advantages in use are:

1. Ability to plumb over the lifting point.
2. Single-man operation, controlling luffing, slewing and hoisting.
3. Straight lift means that SWL is usually adequate.

Disadvantages in use are:

1. Complexity of operation requires lengthy maintenance.
2. SWL decreases with jib radius, because the span becomes less effective as it approaches the horizontal.
3. Large amount of deck space required for installation.

Derricks. Advantages in use are:

1. Simplicity of component parts.
2. Ability to change rig to suit loading/discharging requirements.
3. Maintenance is minimal, provided that winches are good.

Disadvantages in use are:

1. Deck is cluttered with guyropes and preventers.
2. Operation usually requires two winch drivers and a hatchman.
3. Time delays in changing derrick rig for different cargoes.

Hallen derrick. Advantages in use are:

1. Simplicity of components in comparison to a crane.
2. Single-man operation, controlling luffing, slewing and hoisting.
3. Can be used against a 15° list, and can lift its full capacity, down to a 15° angle above the horizontal.
4. Comparatively clear decks – no guyropes nor preventers.
5. Up to 200 tonnes capacity derrick operates with speed appropriate to light loads. Only cargo hoist needs changing for different load requirements.

Stulcken derrick. Advantages in use are:

1. Can be used at the *two* hatches forward and aft of derrick rig.
2. Topping lift also acts as guys, as in Hallen derrick.
3. Conventional lighter derricks can be fitted either side.
4. Single-man operation with mobile control unit.

Velle crane. Advantages in use are:

1. Simple components in comparison to crane – similar to Hallen derrick.

2. Single-man operation, controlling luffing, slewing and hoisting.
3. Arrangement damps pendulation/rotation of load, which allows the operator to luff and slew at the same time, with quicker handling.
4. Comparatively clear decks – no guyropes nor preventers.

DERRICK TESTS AND SURVEYS

It is a requirement of most national regulations that cargo-handling gear should be inspected once a year by the Chief Officer (Annual Inspection), in addition to the usual working checks by the Officer of the Deck. The cargo-gear would also be thoroughly examined under survey every five years.

The surveyor at both the annual and the 5 yearly inspections will pay particular attention to all associated fittings on the derrick, mast and deck. He will check for any excessive wear or corrosion, and may carry out hammers tests. All blocks, shackles, links, chains, and wires will be examined to ensure that they are all in a satisfactory condition. Should any component have suffered damage, this should be replaced, and, provided that the component is individually tested, a retest on the rig is not required.

When a survey inspection takes place, the gear will be given a more detailed examination, and a drilling test may be required. It is recommended that the derrick should be retested at the third and each subsequent survey inspection.

Where the SWL of a derrick exceeds 15 tonnes, the proof load (see Table 5.3) is to be applied by hoisting movable weights by the cargo purchase, and with the weights in the hoisted position the derricks are to be swung as far as possible in both directions. Where the SWL is 15 tonnes or less, the proof load may be applied, if desired, by means of a spring or hydraulic balance.

TABLE 5.3 Tests on derricks

<i>Safe working load</i>	<i>Proof load</i>
Up to 20 tonnes	25% in excess of SWL
Exceeding 20 tonnes but not exceeding 50 tonnes	5 tonnes in excess of SWL
Over 50 tonnes	10% in excess of the SWL

RIGGING OF SHEER LEGS

The sheer legs is a temporary structure used when a derrick is not available. The rigging of sheer legs (Figure 5.17) was originally used for the stepping of the lower mast of a square rigged vessel, and for the loading and discharge of weights to and from the ship. Advances in lifting gear have made the rig more or less obsolete, except in the areas of training exercises for young seafarers.

The rig is constructed by placing two spars together with the heads raised above the deck for the purpose of passing the head lashing, which

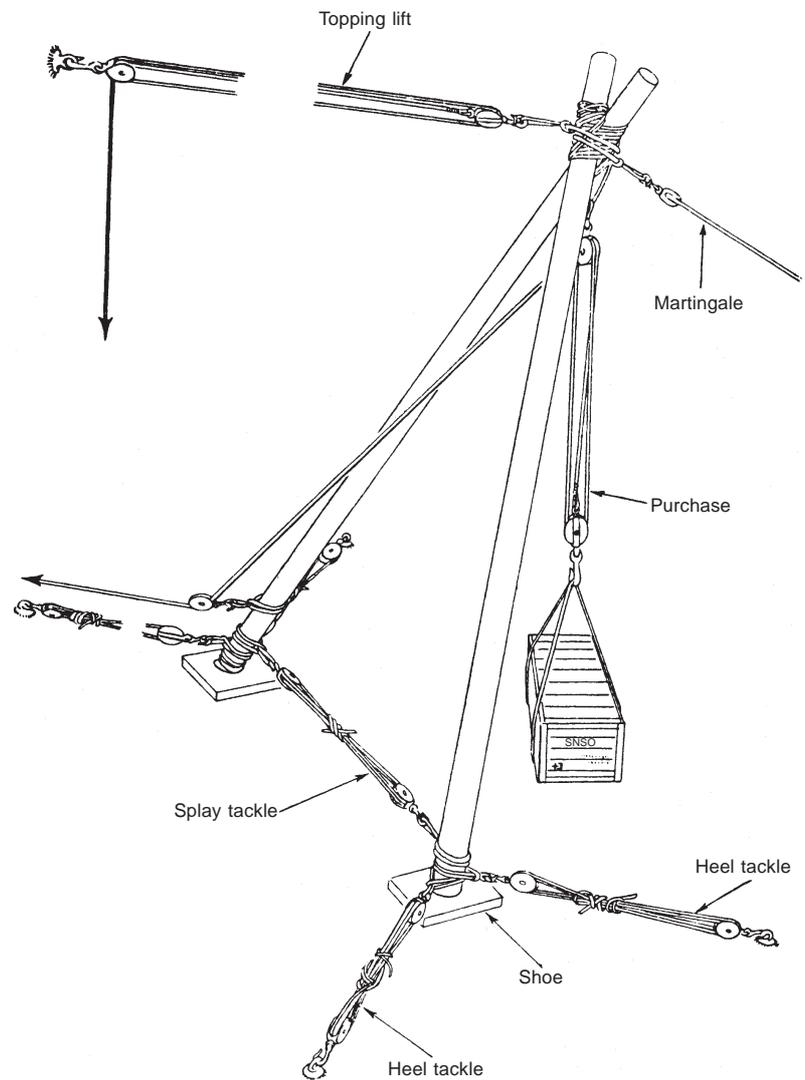


Figure 5.17 Rigging of sheer legs.

is started with a timber hitch or an eye splice about one of the spars. About fourteen turns are then taken about the two spars, then the end is passed between the legs and a further four or five frapping turns are bound about the initial lashing, so binding it together. The end is then secured by a clove hitch about the opposite leg from which the lashing was commenced.

Once the legs are splayed apart, the head lashing will be seen to be drawn taut. The heels of the legs are then placed into shoes to spread the pressure acting down the leg when in the upright position. Strops are placed about the head lashing and the spars to accommodate the topping lift and the martingale, together with the lifting purchase.

Additional strops are positioned about the spars just above the heel of each. Heel tackles are secured (two to each leg), and a splay tackle is set taut between the legs.

The topping lift should be secured at the head of the sheer legs and the weight taken. Care should be taken to ensure that men brace themselves against any movement of the shoes in the process of raising the legs when taking up the weight of the topping lift. Once the legs are held in the semi-raised position, a martingale should be secured at the head of the rig. This acts in opposition to the topping lift to control and prevent the legs toppling through 180°, if not required.

Secure the lifting purchase via the strops at the head of the rig when the legs are at a convenient height. Continue to take up on the topping lift and ensure that the lower block of the purchase is retained at deck level.

RIGGING OF GYN

This rig employs three spars, which are secured to form a tripod. It is a stronger rig than sheer legs but is used for vertical lifts, whereas the sheers are employed for moving lifts from side to side. The gyn is constructed by lashing the three spars together at the head, in a similar manner to sheer legs. Splay tackles or additional spars may be secured between legs to prevent the rig collapsing and to provide extra strength.

The gyn can be erected manually when the legs are of limited length. Should the length of legs be unmanageable, then a topping lift arrangement will be required.

This rig is not in general use because of modern cargo-handling methods. However, it is employed by the coastguards when they are engaged in rigging and operating a breeches buoy system. They refer to it as a tripod for the purpose of securing the lead block to accommodate the whips to the breeches buoy (or the hawser, depending on the type of rig being used). The so-called tripod is a quickly assembled light tubular steel structure, hinged, not lashed, at the head.

NB. Helicopters have largely superseded the use of breeches buoy operations.

HAND SIGNALS

Directions need to be given when winches, cranes and derricks are working. The code of hand signals is illustrated in Figure 5.18.

CALCULATING STRESSES IN DERRICKS BY EMPIRICAL FORMULA

The cargo officer should be aware that when using the empirical formula, shown with the following examples, the additional effort applied to the hauling part to overcome friction has always been taken as one-tenth. This may not necessarily always be the case. Cargo-handling gear may achieve efficient bearings, but this cannot be guaranteed 100 per cent and the allowance for friction should be based on the advice of the manufacturer.

When calculating the size of wire or rope to use in a tackle, the SWL is taken as one-sixth of the breaking strain. However, industry may in practice operate safe working loads of one-fifth of the breaking strain.

It should also be remembered that less friction is encountered when using sheaves of a large diameter than sheaves of a small diameter. Similarly

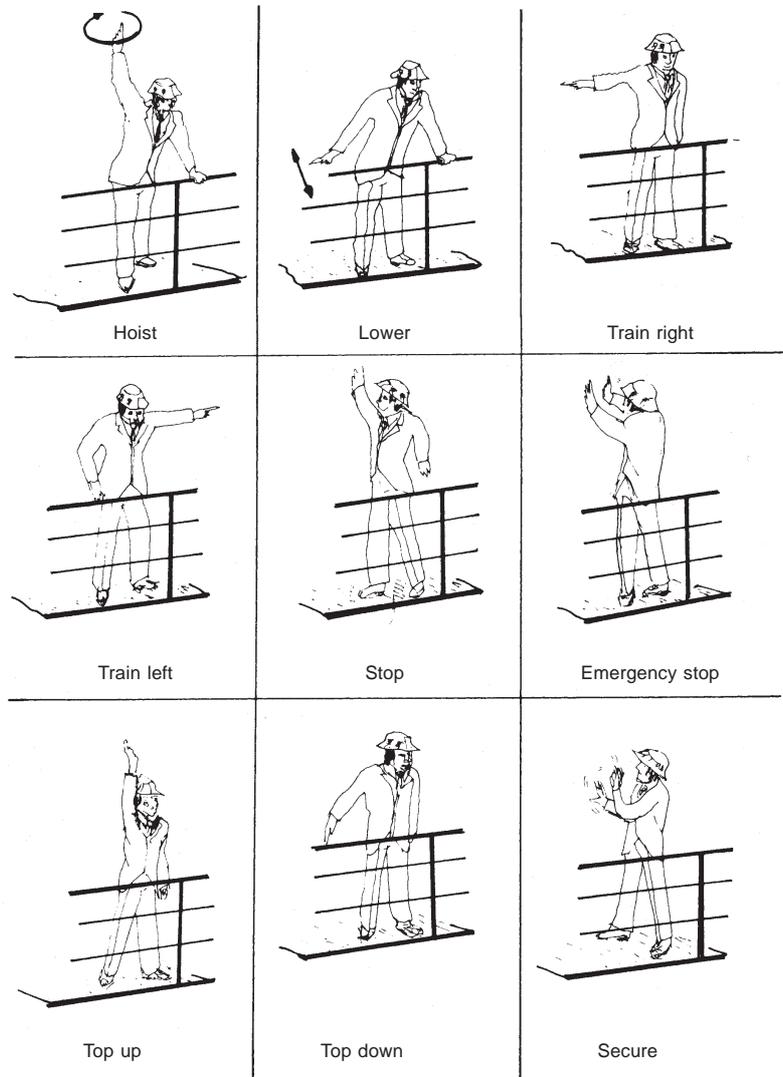


Figure 5.18 Code of hand signals used when working winches, cranes or derricks.

less friction is found when using a thinner rope than a thicker. Consequently, maximum advantage is gained by the use of the larger sheaves and the thinner rope.

Should a heavy lift be required, the officer should bear in mind that a multi-sheave block (over four sheaves) will have a considerable weight of its own. The rig will add additional weight to the load and could effectively neutralise any mechanical advantage gained by the use of a heavy duty rig.

EXAMPLE 1

Calculate the size of manilla rope to use if the stress on the hauling part will be not greater than 3 tonnes.

Use the formula $\frac{2D^2}{300}$ as the breaking strain for manilla rope.

$$\frac{\text{Breaking strain}}{6} = \text{Safe working load}$$

As the given stress on the hauling part = 3 tonnes, the SWL = 3 tonnes.

$$\frac{2D^2}{300} = 3 \times 6$$

Transpose

$$2D^2 = 18 \times 300$$

$$D^2 = \frac{18 \times 300}{2}$$

$$D^2 = 2700$$

$$D = \sqrt{2700}$$

$$\text{Diameter of rope} = 51.96 \text{ mm} = \underline{\underline{52 \text{ mm}}}$$

EXAMPLE 2

Calculate the size of flexible steel wire rope to use if the stress on the hauling part of the wire is 3.75 tonnes. The construction of the wire is (6 × 24) wps. Use the formula $\frac{20D^2}{500}$ as the breaking strain for steel wire rope.

$$\frac{\text{Breaking strain}}{6} = \text{Safe working load}$$

As the given stress on the hauling part = 3.75 tonnes, SWL = 3.75 tonnes.

$$\frac{20D^2}{500} = 3.75 \times 6$$

$$20D^2 = 22.5 \times 500$$

$$D^2 = \frac{22.5 \times 500}{20}$$

$$D = \sqrt{562}$$

$$\text{Diameter of wire} = 23.7065 \text{ mm} = \underline{\underline{24 \text{ mm}}}$$

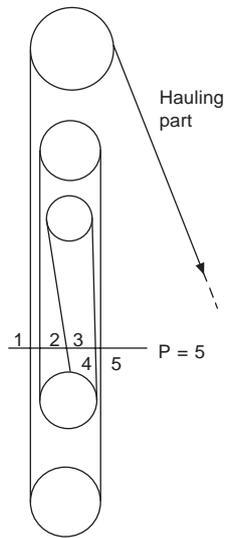


Figure 5.19

EXAMPLE 3

Calculate the stress on the hauling part of a gyn tackle rove to disadvantage (3 and 2, sheaves), and used to lift a load of 1 tonne (see Figure 5.19).

$$S = \frac{W + \frac{n \times W}{10}}{P}$$

where S = Stress in hauling part.
 W = Load being lifted.
 n = Number of sheaves in tackle.
 P = Power gained.

$$S = \frac{1 + \frac{5 \times 1}{10}}{5}$$

$$= \frac{3}{10}$$

$$= \underline{\underline{0.3 \text{ tonnes}}}$$

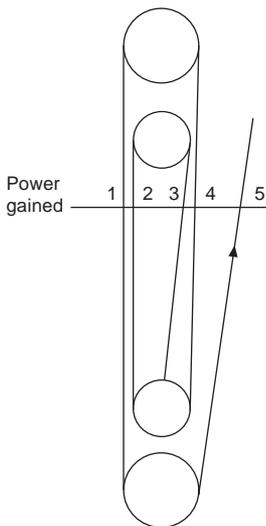


Figure 5.20

EXAMPLE 4

Calculate the stress on the hauling part of a double luff tackle rove to advantage (double purchase 2 and 2 sheaves), when used to lift a load of 5 tonnes (see Figure 5.20).

$$S = \frac{W + \frac{n \times W}{10}}{P}$$

where S = Stress in hauling part.
 W = Load being lifted.
 n = Number of sheaves in tackle.
 P = Power gained.

$$S = \frac{5 + \frac{4 \times 5}{10}}{5}$$

$$= \frac{7}{5}$$

$$= \underline{\underline{1.4 \text{ tonnes}}}$$

Use of the above empirical formula in the examples shown takes into consideration that the allowance for friction is about one-tenth of the load to be lifted for each sheave in the purchase. The allowance for friction is added to the load that is to be lifted. Effectively the increase in the load on the hauling part necessary to overcome friction is spread almost equally between the several parts of the purchase.

EXAMPLE 5

A 5-tonne load is to be lifted by means of a gun tackle used to disadvantage. Find the approximate stress on the hauling part of the tackle, and the minimum size of wire you would use in the tackle (see Figure 5.21).

$$S = \frac{W + \frac{n \times W}{10}}{P}$$

where S = Stress in hauling part.
 W = Load being lifted.
 n = Number of sheaves in tackle.
 P = Power gained.

$$S = \frac{5 + \frac{2 \times 5}{10}}{2}$$

$$= \frac{6}{2}$$

$$= \underline{\underline{3.0 \text{ tonnes}}}$$

$$\frac{BS}{6} = SWL$$

$$\frac{20D^2}{500} = 3.0 \times 6$$

$$20D^2 = 18 \times 500$$

$$D^2 = \frac{18 \times 500}{20}$$

$$D = \sqrt{450}$$

$$= 21.213 \text{ mm} = \underline{\underline{22 \text{ mm}}}$$

EXAMPLE 6

A 10-tonne load is to be lifted by means of a double luff tackle used to disadvantage, with a gun tackle rigged to advantage secured to the hauling part of the luff tackle. Calculate the stress on the hauling part of the gun tackle. (Note that the power gained by the combination of two purchases, is approximately equal to the product of their separate powers ($4 \times 3 = 12$) (see Figure 5.22).

$$S = \frac{W + \frac{n \times W}{10}}{P}$$

where S = Stress in hauling part.
 W = Load being lifted.
 n = Number of sheaves.
 P = Power gained.

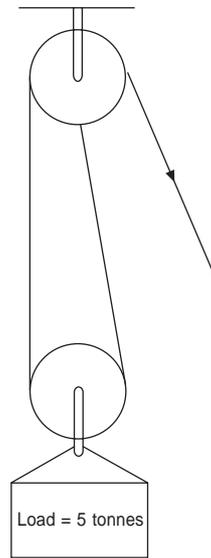


Figure 5.21

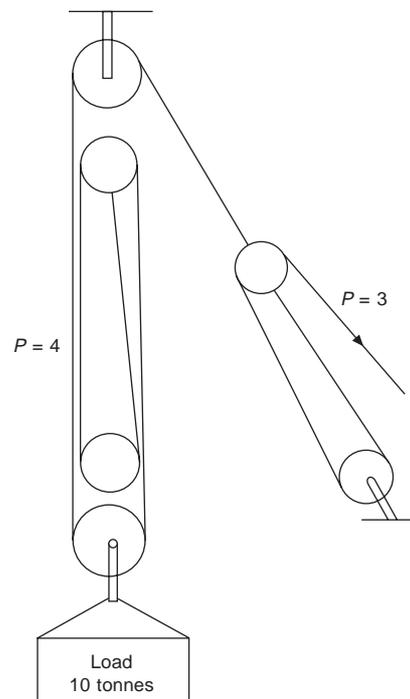


Figure 5.22

$$S = \frac{10 + \frac{6 \times 10}{10}}{12}$$

$$S = \frac{16}{12}$$

$$= \underline{\underline{1\frac{1}{3} \text{ tonnes}}}$$

Stresses Involved in the Use of Derricks

It is not the intention of this text to involve the reader in physics, but it is considered necessary that the cargo officer is aware of the methods of using the parallelogram of forces to obtain the stresses that may be encountered in practice when using derrick rigs. Assuming a single swinging derrick the areas of stress when lifting a load will be as follows:

- (a) the stress in the downhaul of the lifting purchase,
- (b) the resultant load on the head block,
- (c) the tension in the topping lift span,
- (d) the resultant thrust on the derrick,
- (e) the stress on the heel block,
- (f) the stress on the span block.

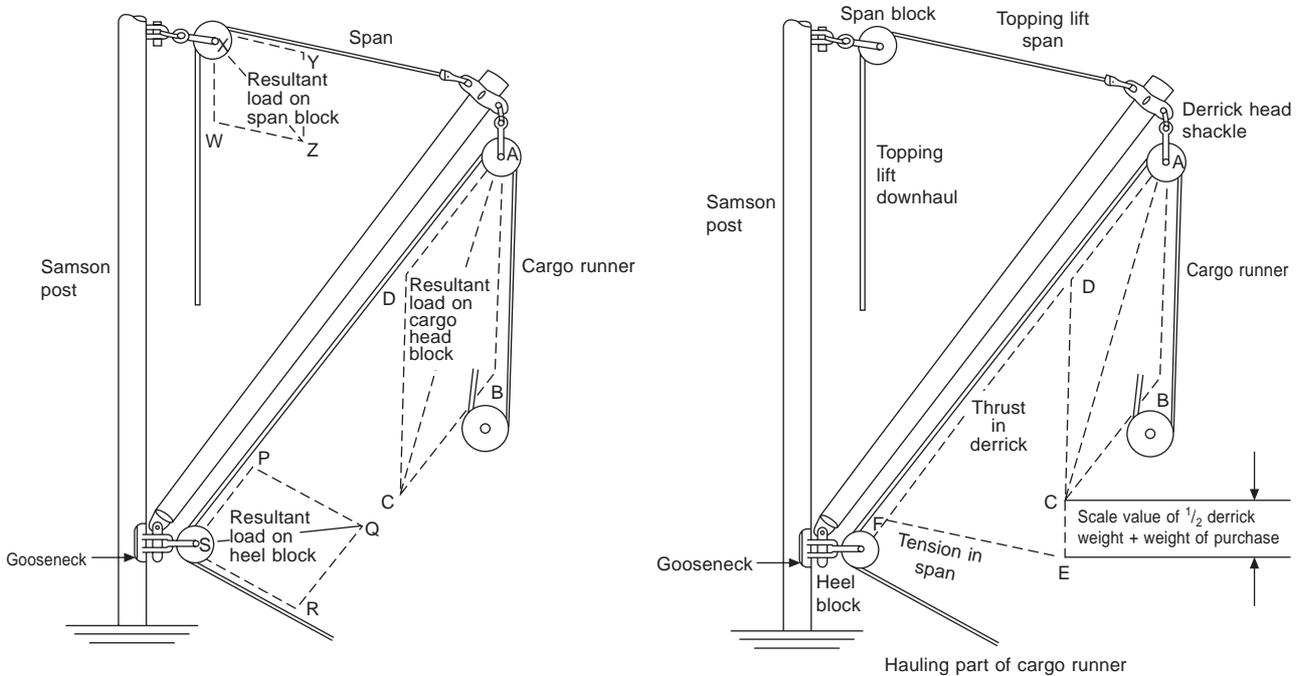


Figure 5.23 Derrick work calculations.

(a) *The stress in the downhaul of the lifting purchase.*

This may be found by use of the empirical formula as shown with previous examples.

$$S = \frac{W + \frac{n \times W}{10}}{P}$$

(b) *To obtain the resultant load on the head block (derrick head shackle)*

The construction of a parallelogram of forces similar to that of ABCD, should be made with scaled values for the stress in the hauling part of the lifting purchase (AD) being resolved against the scaled value of the weight, being lifted (AB).

Once these two forces are resolved then the resultant force at point 'A' (derrick head) is represented by the scale value AC.

AD represents the calculated stress in the hauling part of the lifting purchase.

AB represents the weight/load being lifted. (This is always acting vertically due to the force of gravity.)

By resolving the forces AD and AB into the parallelogram ABCD. AC represents the resultant stress acting on the derrick head shackle.

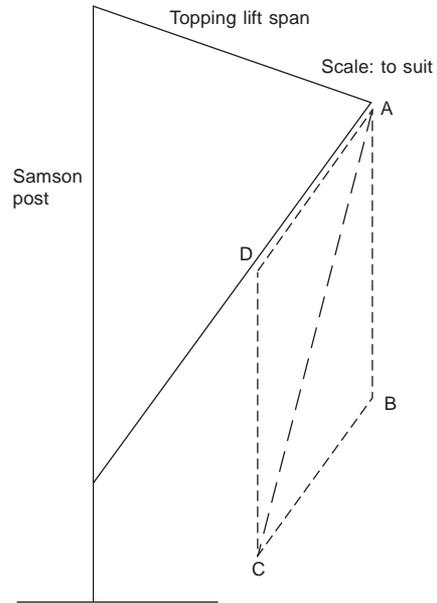


Figure 5.24

(c) *To obtain the tension in the topping lift span*

By employing the vector produced which represents the stress on the derrick head shackle (AC from the previous diagram) and the length of the derrick itself, the tension in the topping lift span can be obtained by scaled construction.

By construction AC represents the resultant stress acting on the derrick head shackle, caused by the load AB acting vertically down.

By construction of the parallelogram ACFE, FC parallel to AE represents the tension in the topping lift span.

(d) *To obtain the thrust on the derrick*

The reader should bear in mind that the forces which produce thrust in the derrick are the tension in the topping lift span and the total load on the head shackle.

By use of Figure 5.25, where AC represents the resultant load on the derrick head shackle. AE represents the tension in the topping lift span.

In parallelogram ACFE, AF represents the thrust on the derrick (by scale measurement).

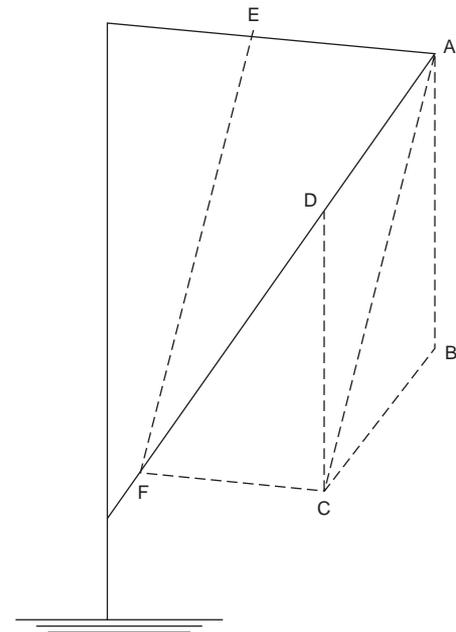


Figure 5.25

(e) *To obtain the stress on the heel block (Figure 5.23)*

(A vector is a quantity having magnitude and direction.)

By scaled construction similar to the parallelogram PQRS the vectors representing the stress in the wire should be plotted from the position of the heel block:

SP represents the stress in the downhaul of the cargo runner, acting in the direction of the derrick.

SR represents the stress in the cargo runner acting in the direction of the winch.

SQ represents the resultant stress on the heel block.

(f) *To obtain the stress on the span block*

By scaled construction similar to the parallelogram WXYZ the vectors representing the stress in the downhaul of the topping lift span, and the tension in the topping lift span should be plotted from the position of the span block:

WX represents the stress in the downhaul of the topping lift.

XY represents the tension in the topping lift span.

XZ represents the resultant stress on the span block.

With all calculations obtained by use of scaled diagrams it should be remembered that the larger the scale the more accurate the results will be.

Notes for Solving Problems

1. Always state clearly the scale of the values being used, and display this statement with all diagrammatic calculations.
2. Assume that all wires run in the same direction as a conventional derrick unless another rig is specified. For example, the cargo runner may be assumed to run in a parallel direction to that of the derrick, so that scaled values may be laid off in the same line.
3. Where a purchase is being used, the empirical formula should be applied to obtain the stress on the downhaul of the purchase. This would become the laid off value for the purpose of the scaled value and the construction of the parallelogram, as with, for example, a span tackle topping lift.
4. Unless otherwise stated the allowance for friction per sheave should be taken as 10 per cent of the load being lifted.
5. Always use the largest scale possible, as this will tend to eliminate minor diagrammatic errors.

EXAMPLE 7

A derrick 16 m long is secured by a single span topping lift. The span block is secured 13 m above the heel of the derrick and the length of the span between the head of the derrick and the span block is 8 m. Calculate by scale diagram:

- (a) the resultant load on the derrick head block,
- (b) the resultant thrust in the derrick,
- (c) the tension in the topping lift span, and
- (d) the resultant stress on the topping lift span block,

when the rig is lifting a 4-tonne load by use of a single cargo runner. In Figure 5.26

AX = Derrick 16 m in length.

AY = Topping lift span, 8 m.

XY = Mast derrick heel and span block, 13 m apart.

A = Derrick head block.
 Y = Topping lift span block.

1. In parallelogram ABCD, AB represents the load 4 tonnes.
 Stress in downhaul (single sheave block) = AC = 4 tonnes.
 Resultant load on derrick head block = $7\frac{1}{2}$ tonnes (AD).
2. In parallelogram ADEF, AD is $7\frac{1}{2}$ tonnes, DE represents the tension on the span $2\frac{1}{2}$ tonnes.

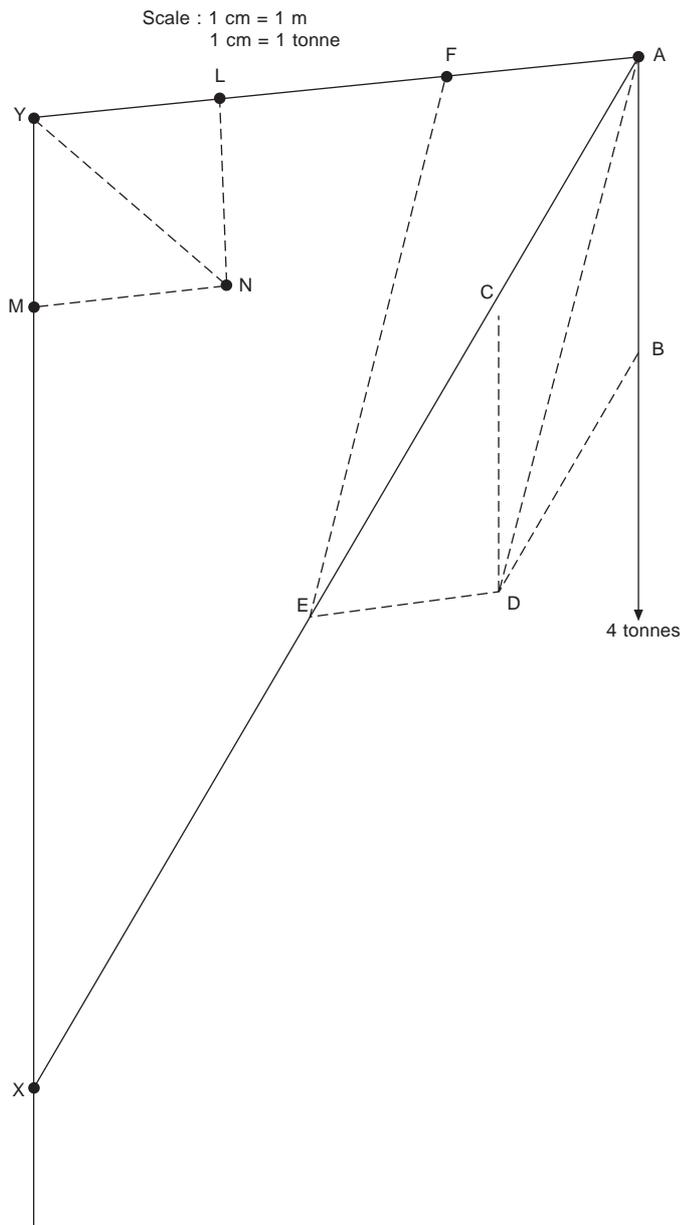


Figure 5.26

- AE represents the thrust on the derrick $8\frac{3}{4}$ tonnes.
3. In parallelogram YLNM,
 $YL = YM = \text{tension in span} = \underline{\underline{2\frac{1}{2} \text{ tonnes}}}$.
- YN represents resultant stress in span block = $\underline{\underline{3\frac{1}{2} \text{ tonnes}}}$.

EXAMPLE 8

A derrick lies at an angle of 40° from a vertical mast (Figure 5.27). A weight of 10 tonnes is being lifted with a gun tackle purchase secured at the derrick head, the hauling part being led to the heel of the derrick. Allowing 10 per cent per sheave for friction, calculate the stress on the derrick head shackle securing the gun tackle (see Figure 5.29 (in the answer below the sign // means 'parallel to')).

Gun tackle

Stress in hauling part of gun tackle is obtained from

$$S = \frac{W + \frac{n \times W}{10}}{P}$$

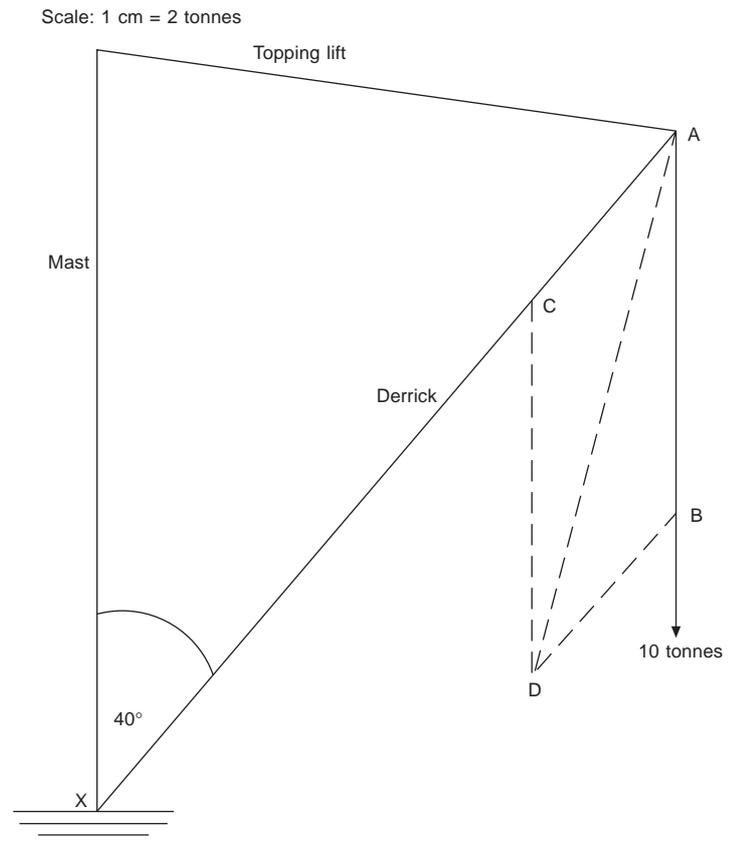


Figure 5.27

$$\begin{aligned}
 & 10 + \frac{2 \times 10}{10} \\
 &= \frac{10}{2} \\
 &= 6 \text{ tonnes}
 \end{aligned}$$

AX represents derrick at 40° to a vertical mast.

AC represents calculated stress in the hauling part of tackle = 6 tonnes.

AB represents load of 10 tonnes acting vertically downward.

Construct BD//AC and CD//AB, to complete parallelogram ABCD.

Then AD represents the stress on the derrick head shackle

= 15.1 tonnes.

EXAMPLE 9

A derrick 40 m long makes an angle of 40° with a vertical mast. A topping lift span is secured 30 m above the heel of the derrick. The rig is to lift 15 tonnes with a three-fold purchase, used to disadvantage, suspended from the head of the derrick. The downhaul from the lifting purchase is led to a heel lead block and then to a winch. The heel of the derrick is 3 m above the deck and the winch point is 3 m away from the heel of the mast, and 2 m above the deck. By scale diagram calculate:

- (a) The stress on the derrick head shackle.
- (b) The thrust in the derrick.
- (c) The tension in the span.
- (d) The stress on the heel block.

(Make normal 10 per cent allowance for friction.)

In Figure 5.28

AX derrick 40 m in length.

AB load of 15 tonnes acting downward.

Stress on the hauling part of the lifting purchase is obtained from

$$\begin{aligned}
 S &= \frac{W + \frac{n \times W}{10}}{P} \\
 &= \frac{15 + \frac{6 \times 15}{10}}{6} \\
 &= 4 \text{ tonnes.}
 \end{aligned}$$

(a) To find the stress on the derrick head shackle

AC represents the stress in the hauling part of the lifting purchase 4 tonnes.

Construct BD//AC and CD//AB, so completing the parallelogram ABCD.

Then AD represents the stress on the derrick head shackle

= 18.4 tonnes.

(c) To obtain the tension in the topping lift span

Construct EF//AD, so completing the parallelogram ADEF.

Then AF represents the tension in the span = 12.5 tonnes.

(d) To find the stress on the heel block

XP represents the stress in the hauling part of the lifting purchase = 4 tonnes, but XP = XR (single wire about a single sheave block).

Construct RQ//XP and PQ//XR, so completing the parallelogram XPQR.

Then XQ represents the resultant force on the heel block = 6.5 tonnes.

EXAMPLE 10 (Figure 5.29)

An 8 m long derrick is secured by a fixed span shackled to a vertical mast 7 m above the heel of the derrick. The span is 6 m in length. A purchase is rove which employs a single sheave set into the central axis at the derrick head and a single floating block above the cargo load. The hauling part from this lifting purchase is led via a lead block, secured just below the fixed span, and via a heel block to a winch. Making 10 per cent allowance for friction, find by scale diagram:

- (a) the resultant stress on the derrick head shackle,
- (b) the thrust in the derrick, and
- (c) the tension in the span,

when lifting a load of 10 tonnes.

AB represents load of 10 tonnes.

AX represents derrick 8 m in length

(a) To obtain the resultant stress on the derrick head shackle

The stress in the hauling part of the lifting purchase must first be evolved from the empirical formula

(Assume that the lifting purchase sheaves are rove as a gun tackle, to disadvantage then power gained = 2)

$$S = \frac{W + \frac{n \times W}{10}}{P}$$

$$= \frac{10 + \frac{2 \times 10}{10}}{2}$$

$$= \underline{\underline{6 \text{ tonnes}}}$$

Then AC = 6 tonnes.

Construct BD//AC and CD//AB, so completing the parallelogram ABDC.

AD represents the resultant stress on the derrick head shackle = 10.3 tonnes.

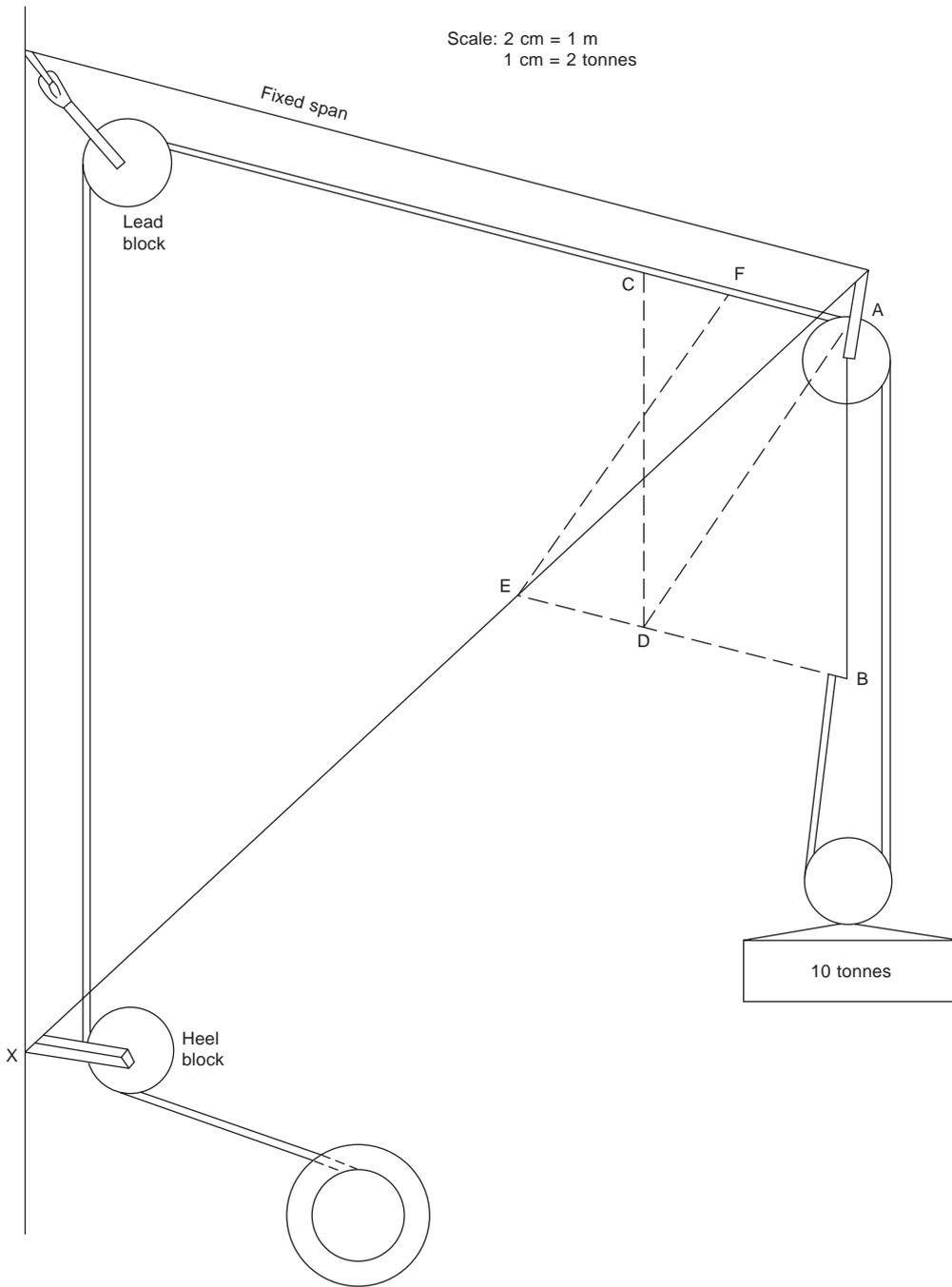


Figure 5.29

(b) To obtain the thrust in the derrick

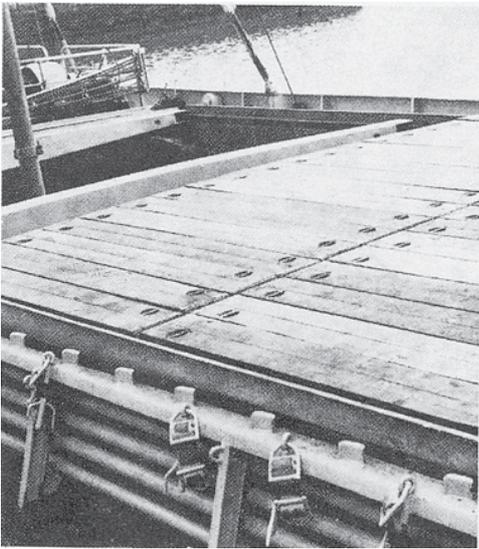
Construct DE parallel to the fixed span, to meet the line of the derrick at E. AE then represents the thrust on the derrick = 12 tonnes.

(Point A assumed to be the derrick end.)

(c) To obtain the tension on the fixed span.

Construct EF//AD, so completing the parallelogram ADEF.
Then AF may be taken to represent the tension in the span = 3.5 tonnes.

CARGO AND HATCHWORK



16. Conventional hatch, with hatchboards in place over half the weather deck hatchway, hatch beams rolled back to allow access for grain elevator sucker, and hatch coaming showing cleats and battening bars.

CONVENTIONAL HATCH

This type of hatchway covering (Figures 6.1 and 6.2) is now rarely seen except on older general cargo vessels. It is a system that has been largely superseded by the steel hatch covers, which provide a more secure seal and are far more labour-saving than the conventional hatch. See also Plate 16.

The hatchway is covered by the spreading of athwartships beams at regular intervals down the length of the coaming. The beams may be fitted with rollers to facilitate manhandling into position and sited with beam bolt securings. Other designs as illustrated being secured by beam sockets. Either system lends itself to the removal of all hatch beams when required, e.g. when working long loads. When the ship is being moved in port limits, it is essential that the beams are set in position to provide continuity of strength athwartships, in case the vessel lands heavily against the dock wall. Hatch boards are then placed between the 'king beams'. The 'queen beams' are positioned to pass under the centre of each row of hatch boards. Boards are often marked to identify their order of placing, by use of a coloured painted strip.

The advantage of this type of hatch is that two men can cover the hatch on their own, although this is a slow process. Hatch slabs superseded the conventional hatch boards, but took more manpower to 'hatch up'. They were positioned by use of a derrick or crane but employed usually a minimum of four men, one of whom handled the winch. A hatch slab is the size of four or five hatch boards, with the equivalent weight.

Once the conventional hatch was covered by either hatch boards or slabs it was normal practice to cover the top with a minimum of three tarpaulins, the oldest being stretched first, the newest second and the intermediate tarpaulin last. All three carried an overlap, and in the first-laid this was 'tabled' under (folded to level the edge of the coaming). The last two tarpaulins were tucked into cleats set around the hatchway coaming, the corners of the top tarpaulin being mitred away and opposite from the direction of the forward and prevailing weather.

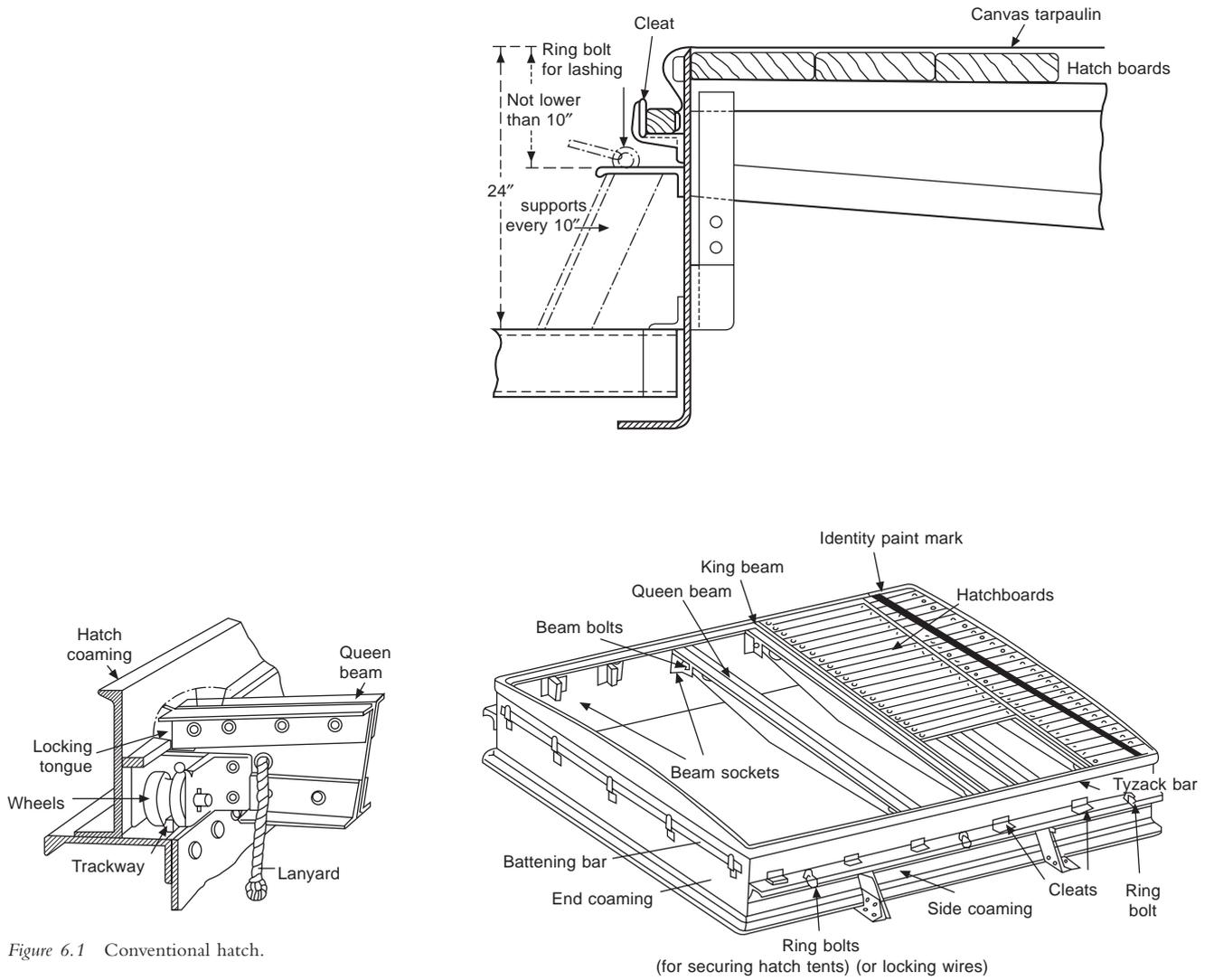


Figure 6.1 Conventional hatch.

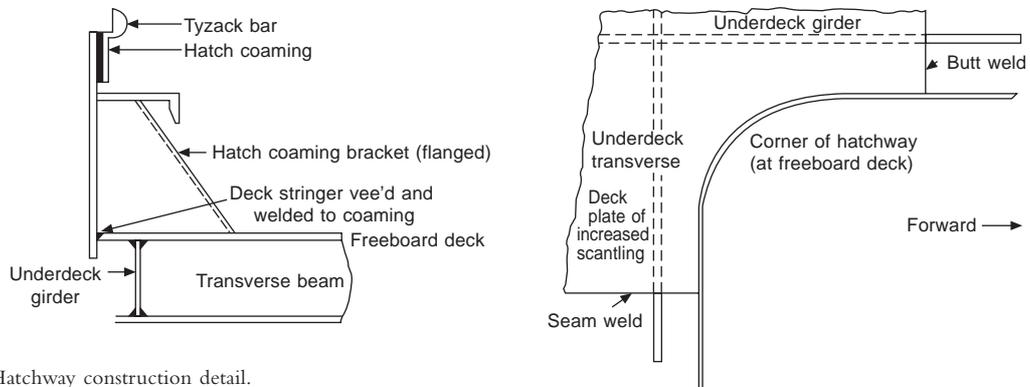


Figure 6.2 Hatchway construction detail.

The cleating arrangement was such that once the tarpaulins had been tucked, battening bars (steel) would be inserted on top and secured by wooden wedges. It was important to secure the wedge correctly into the cleat, or, when hammering home, the grain could split on the edge of the cleat.

Finally tarpaulins and hatch boards were secured by locking bars or locking wires over the complete hatch, to prevent the coverings from blowing adrift and as an anti-theft device. Should the vessel's freeboard ever be lost, locking bars would also restrict the wooden hatch covers from floating adrift, an important factor should the vessel be salvaged after a sinking.

Tarpaulins were always laid with their seam edge athwartships and away from the fore end of the vessel. This gave some protection from the forward prevailing weather. Tarpaulins were also marked by eyelets to indicate their newness, while hatch identity was established by the number of knots placed in the securing lashing, a useful practice when several hatch tarps were made up and stowed together.

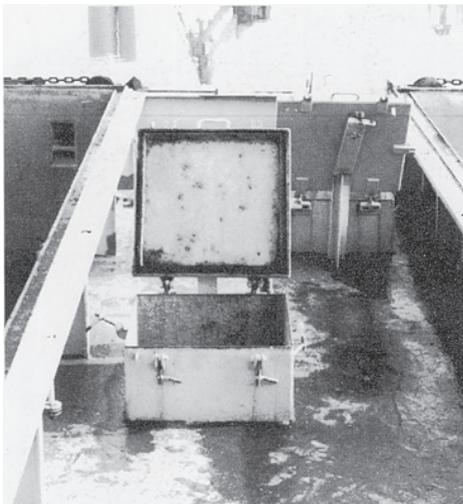
Securing the Hatch for Sea

Once the cargo work has been completed, the beams positioned, and the hatch boards replaced, the three tarpaulins will be stretched in the order stated. Battening bars will then be forced between the cleats and the tucked overlap of the two tarpaulins, and secured against movement by wood wedges being hammered into the cleats. It is important that the wedge is hammered in from the correct direction, namely with the long side against the battening bar. The wedges should be hammered in by use of a wooden mallet, hammering in the direction of the grain of the wood. The flat end of the wedge is forced forward so as to be driven in by any head-on weather, as opposed to being forced out.

The heavy iron locking bars are then secured across the top of the hatch, being hooked under the upper lip of the coaming and drawn together in the middle of the hatch by means of a worming screw arrangement which may be locked by a padlock. The number of pairs of locking bars to a hatch will ultimately depend on the length of the hatchway and the number of hatch board sections as per rigging plan. Each section of board should ideally be secured by at least one pair of locking bars.

Hatch Tents

As is often the case, when the vessel is working cargo, rain may interrupt the normal working operation. With the conventional hatch it proved a laborious task to re-cover the hatchway every time a shower stopped work, and so a tent, similar to a bell tent, was hoisted, usually from a derrick head. The base area of the tent was sufficient to cover the total hatchway area, and the tent was secured by tails to a wire stay running around the hatch coaming. This method was a simple but time-saving exercise, which prevented the cargo getting wet. The tent was easy to put in place and could be just as easily cleared.



17. Booby hatch access to hold.

With the efficient opening and closing of steel hatch covers today, tents are not required for the modern vessel.

CONVENTIONAL HOLD

Construction

The hatchway entrance is a cut-away from the upper deck stringer plates. The corners of the hatchway are cut on the round to provide continuity of strength and prevent shearing stresses causing cracks athwartships and bending forces causing cracks in the fore and aft line. The corner turns of the hatchway are often fitted with reinforcing bars to prevent loading and racking stresses (Figure 6.2).

Tank Top Ceiling

This is a wooden sheathing over the double bottom tank tops, usually in way of the hatch, providing the tank tops with some protection from wear and tear. The ceiling also assists ventilation and drainage of cargoes, and with many cargoes relieves the necessity for laying of double dunnage.

This wood covering may come in one of two forms – either wide flats, laid on bearers which leave space for liquids to drain off to the bilges, or set close into a composition of cement and Stockholm tar.

When bulk cargoes are being regularly carried, the second method is often employed, as the drainage spaces tend to become choked when the first method is used.

It is not uncommon to see the most modern vessel with no tank top ceiling at all, but in this case the tank top itself is normally protected by having increased scantlings.

Turn of the bilge construction is shown in Figure 6.3.

Spar Ceiling

This may be in the form of horizontal or vertical wooden battens to keep cargo off the steel work of the ship's side. Contact between the shell plate and the cargo tends to lead to excessive cargo sweat damage, and to prevent this occurrence spar ceiling, sometimes referred to as cargo battens, is secured in cleats throughout a cargo hold and 'tween deck.

Limber Boards

These are wooden boards similar to hatch boards that cover the bilge bays, which are situated at the bottom sides of the lower holds. These bays run the full length of the hold and should be regularly inspected for their cleanliness. The boards are supported by the tank side brackets between the floors and the frames.

Bilge Suctions – Strum Box

The bilge suction (Figures 6.4 and 6.5) is usually found in the aftermost bay of the hold. Vessels normally trim by the stern, so that this aft siting is best for drainage within the confines of the hatch. Scupper pipes tend

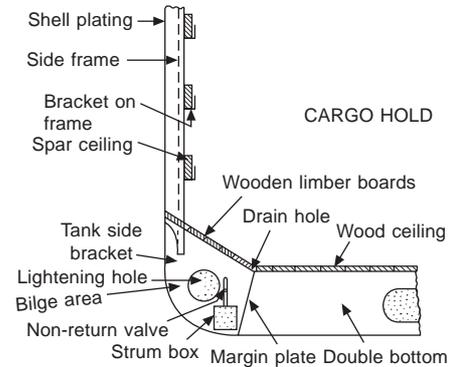


Figure 6.3 Turn of bilge construction.

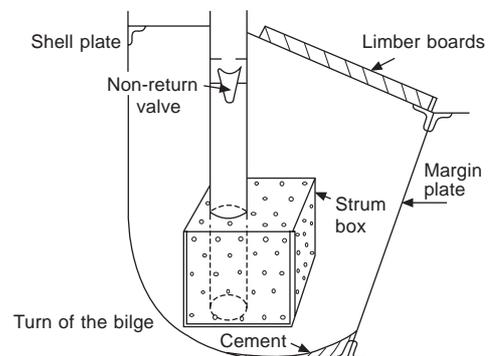


Figure 6.4 Bilge suction – strum box.

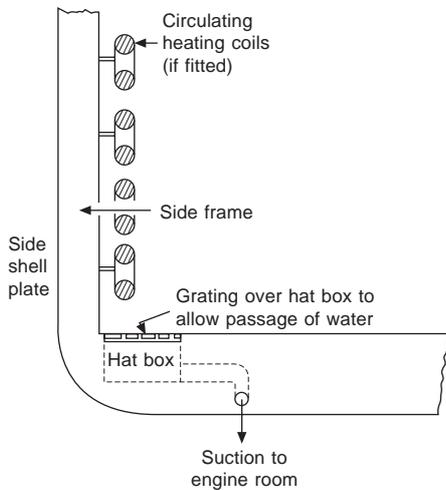


Figure 6.5 Deep tank suction – hat box.

to drain direct from the afterpart of the 'tween deck into the bay containing the strum box.

A non-return valve must be fitted clear of the strum, and in the more modern vessels this valve is situated clear of the bilge area. The purpose of the non-return valve is to prevent accidental run back from the pumps, which may cause flooding in the hold. The suction end of the pipe is kept clear of obstructions by the strum box arrangement built about the pipe opening. This strum box is so constructed as to allow the passage of water but not the passage of solids, which could interfere with suction. The sides of the strum are either slotted or hinged to a framework which will allow the box itself to be dismantled for cleaning and maintenance. The whole bay containing the strum is covered by limber boards.

General Cargo Vessel Deep Tanks

General arrangements vary especially in the securing of the deep tank lids and the number of tanks constructed. It is normal to find deep tanks in pairs or, if situated in a large hatch, then 2×2 pairs, to port and starboard. They are extensively used for bulk cargoes such as grain or chemicals but very often fitted with steam heated coils for the carriage of such things as 'Tallow'. They may also be used to take on extra ballast when the vessel is in a light condition.

Hat box pumping arrangements are operated from the ship's engine room and the lines are fitted with a blanking off fitment when required. Most systems allow for gravity filling and tanks are all fitted with air and sounding pipes (Figure 6.5).

STEEL HATCH COVER

The more modern type of cargo vessel will be equipped with one of the many types of steel hatch cover which are at present on the commercial market (Figure 6.6). The many advantages with this style of cover by far outweigh the disadvantages. They are fast in closing or opening, and the latest versions are so labour-saving that one man could open up all the

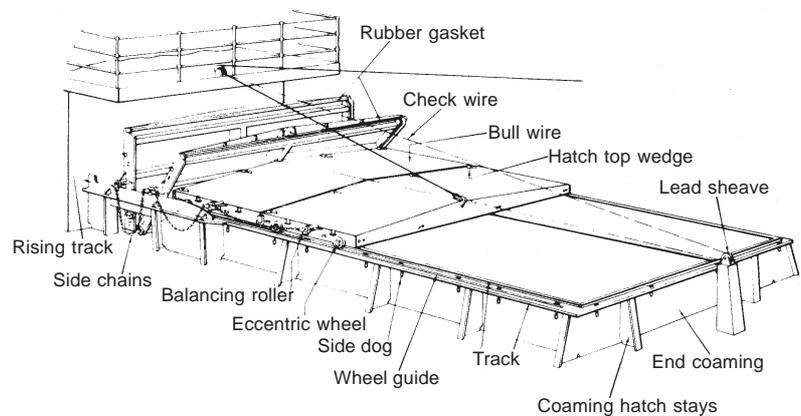


Figure 6.6 Single pull steel hatch cover.

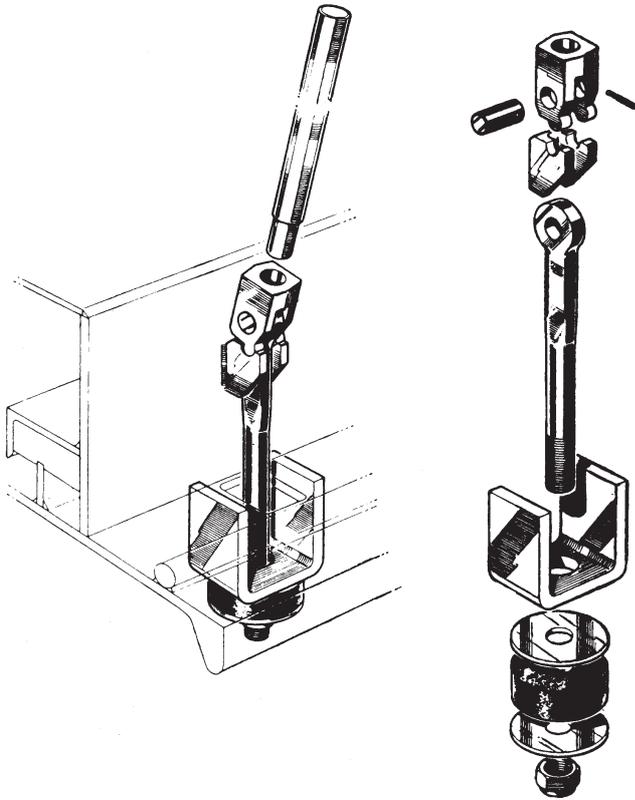


Figure 6.7 Securing steel covers. Cleating (dogging) arrangement.

hatches of a ship in the time it takes to strip a single conventional hatch. Their structure, being of steel, is extremely strong and generally forms a flush surface in 'tween deck hatches providing ideal conditions for fork lift truck work. Steel covers may be encountered not just at the weather deck level but throughout a vessel, inclusive of 'tween decks. Hydraulic operated covers are simple in operation, but should hydraulic fluid leak at any time, cargo damage may result. The direct pull type must be operated with extreme care, and all safety checks should be observed prior to opening the chain-operated types.

Steel covers are illustrated in Figures 6.6 to 6.12 and Plates 18 to 23.

Opening Single Pull Macgregor Steel Hatch Cover

1. Release the side securing lugs, ensuring that they are correctly stowed in flush position with the track.
2. Clear away any hatch top wedges between hatch sections.
3. Rig the check wire to the lug of the leading hatch section and turn up the bight of the wire on to cleats or bitts.
4. Rig the bull wire so as to provide a direct pull to the winch from the leading edge of the hatch cover.
5. Complete all work on top of the hatch covers. Check that the track ways are clear of all obstructions, such as pieces of dunnage etc.

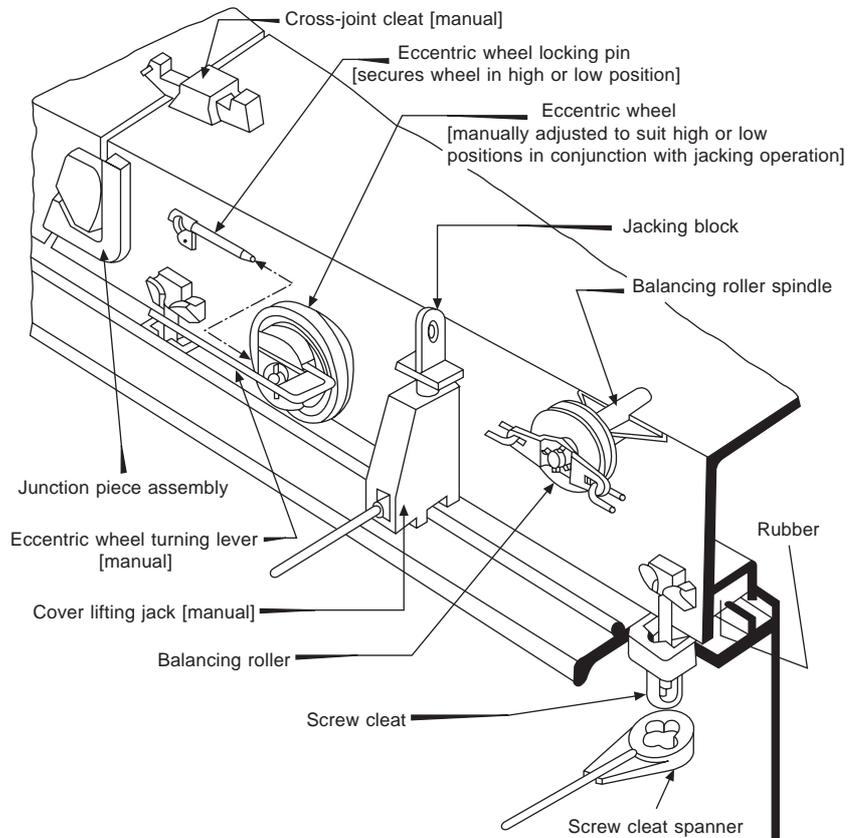


Figure 6.8

6. Turn down the eccentric wheels by use of bar levers, or by using the jacks under the hatch cover sections.
7. Check that the locking pins are securely replaced in the eccentric wheels once the wheels have been turned down to the track, in such a manner that they will not slip out when the wheel rotates or when the hatch is in the vertical stowed position.
8. Ensure that all personnel are aware that the hatch cover is about to open, and that the stowage bay for the covers is empty and clear to allow correct stowage of the sections.
9. Have a man standby to ease the check wire about the bits, and, just before hauling on the bull-wire, remove the locking pins at the ends of the leading hatch section.
10. Heave away easily on the bull-wire once the locking pins are removed, taking the weight of the leading hatch section.
11. Ease out on the check wire as the bull-wire heaves the hatch open (Figure 6.6).
12. Once all hatch sections are in the stowed vertical position, the bull-wire should not be removed until the securing chains from a fixed point are in position to hold back the hatch sections in the stowage bay area.

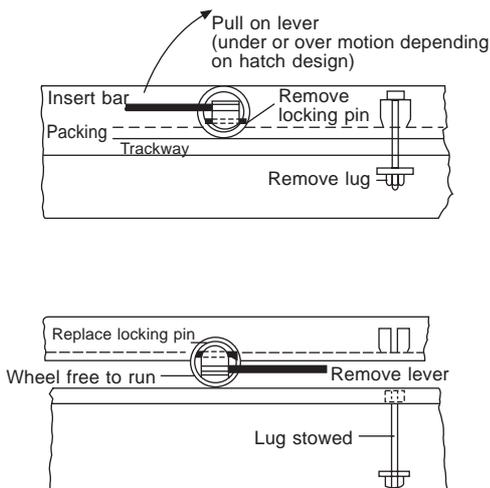
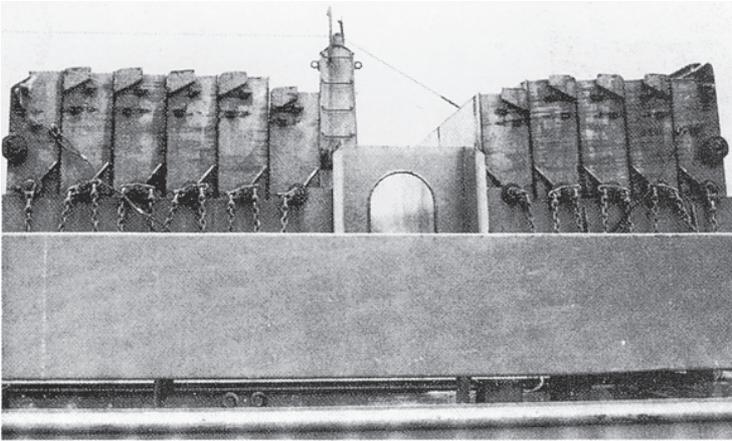
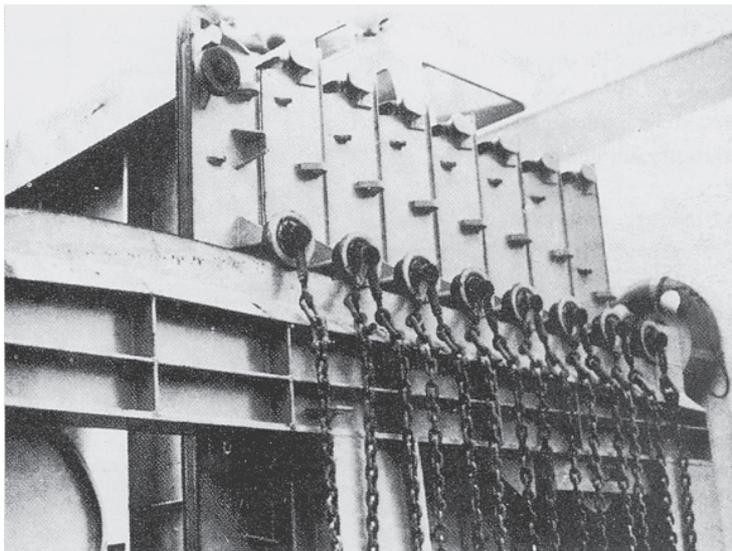
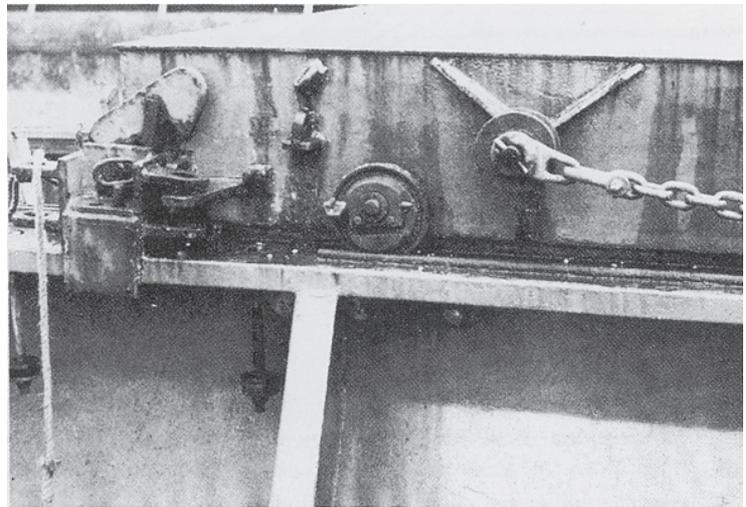


Figure 6.9 Turning down eccentric wheels.

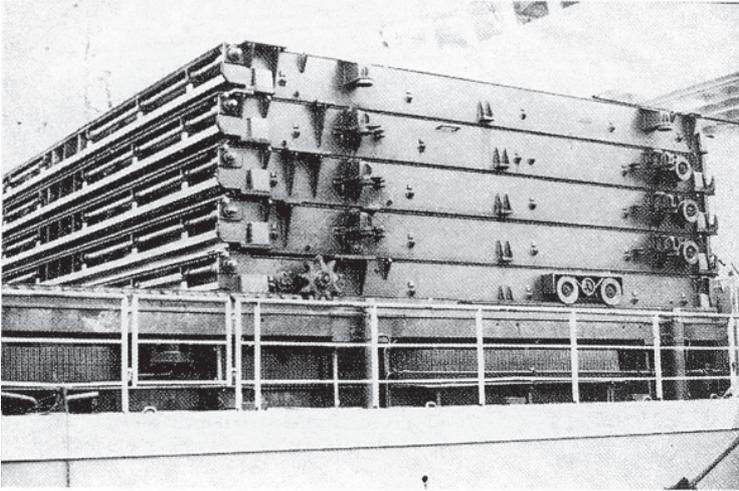


18. Single pull Macgregor steel hatch covers in the stowed upright position, showing fore and aft ends of two separate hatches.

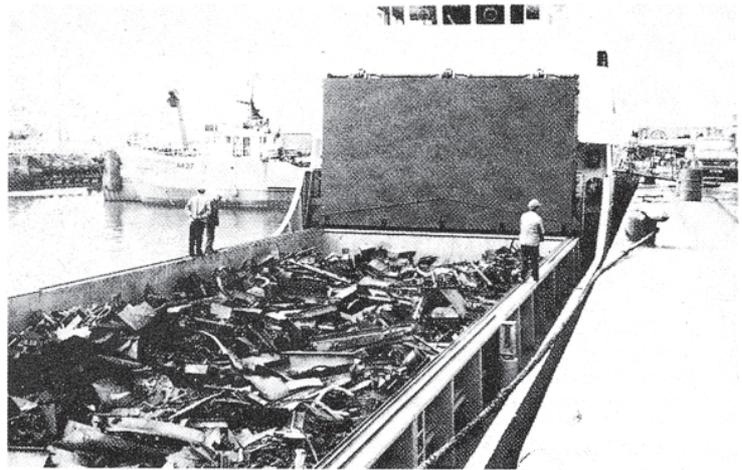
19. Steel hatch cover, with the locking pin seen in the 'out' position. The eccentric wheels are turned down on to the trackway so as to raise the hatch. The securing pin through the eccentric wheel is clearly seen passing through at the level of the bush. Side dogs are hanging vertically down under the coaming, and lifting lugs, together with jacking-up plates, are to be observed above the eccentric wheel.



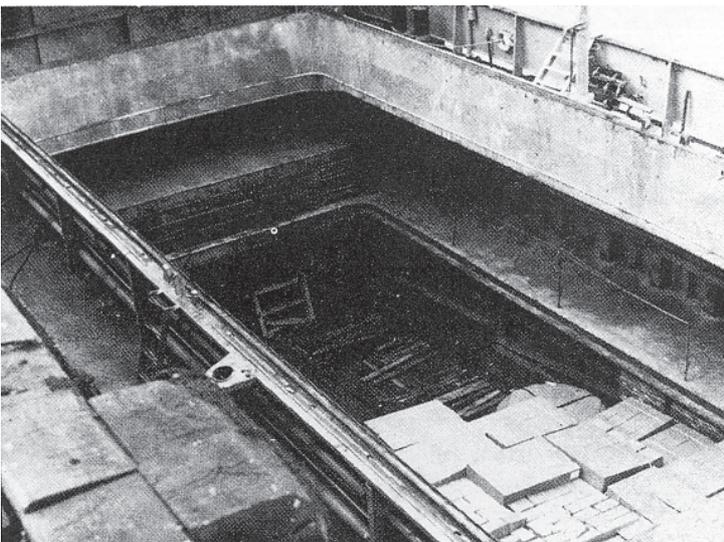
20. Chain pull steel hatch covers in the stowed upright position.



21. Rack and pinion horizontally stowed steel hatch covers.



22. Hydraulic folding Macgregor steel hatch covers (weather deck), and hatchway showing a full cargo of scrap metal.



23. Open hatchway showing exposed 'tween deck space. Pontoon covers are stacked in the after end. Lower hold contains general cargo. Spar ceiling is shown exposed on the lower hold sides.

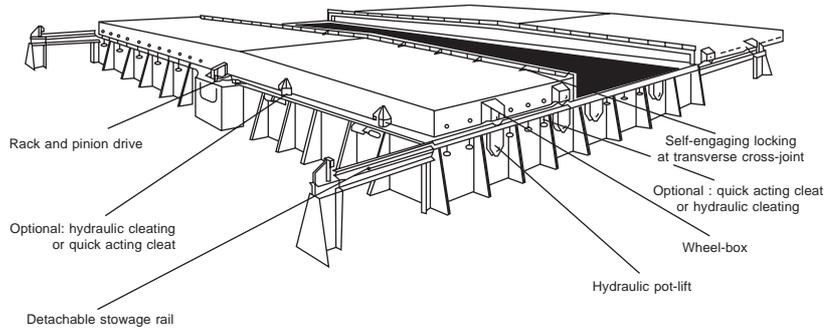
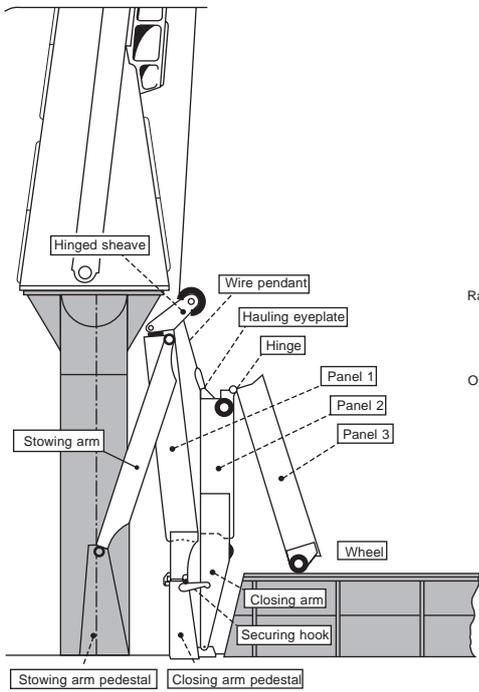


Figure 6.10 Direct pull weatherdeck hatch covers (above). Side rolling covers (right). Rack and pinion drive, with hydraulic lifting and cleating.

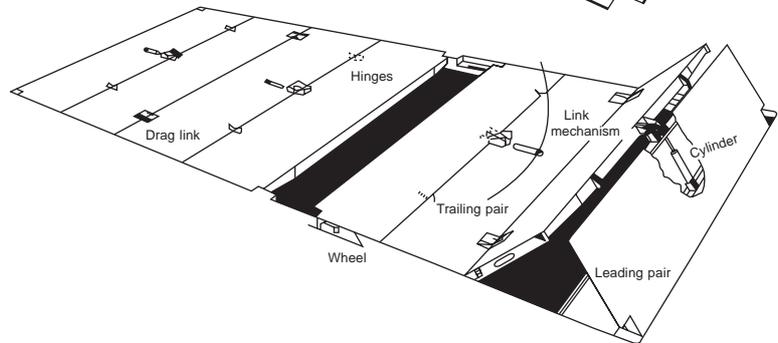
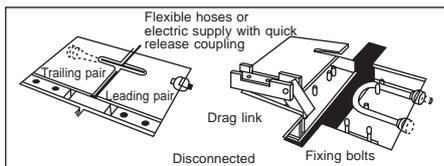
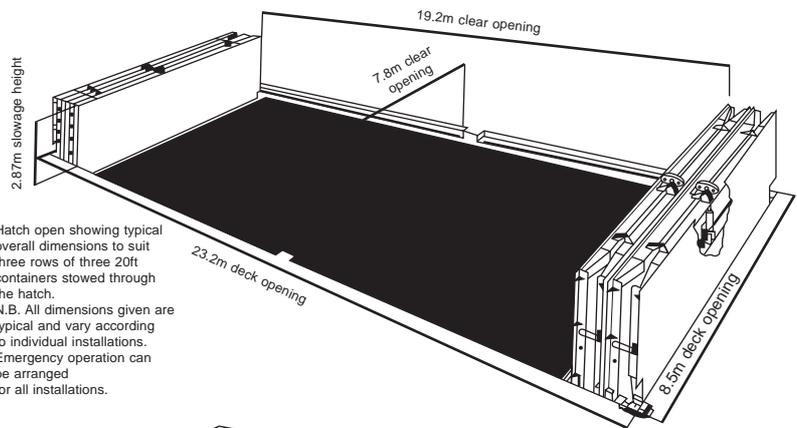


Figure 6.11(a) Steel hatch covers, 'tween deck.

Figure 6.11(b) Weather deck hydraulic folding hatch covers.

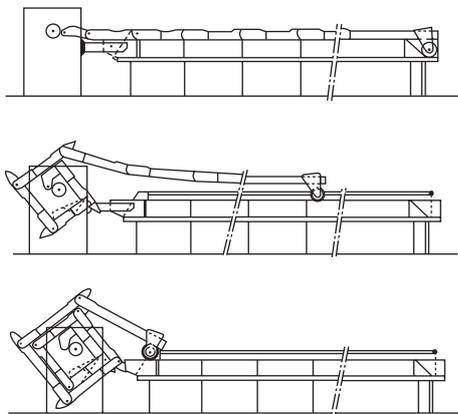
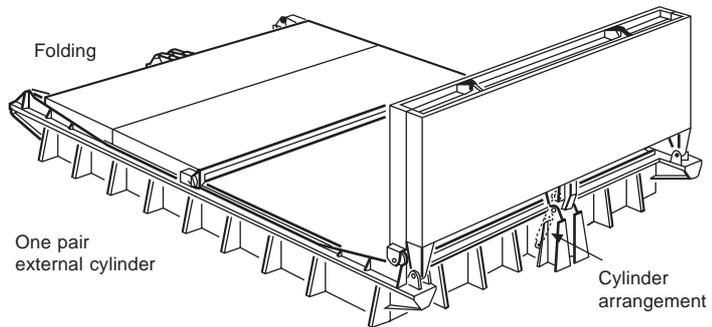


Figure 6.12 Roll stowing covers – Rolltite. Originally designed by Ermans and under manufacture by Macgregor.

13. Clear away the check wire, coiling it down to one side of the hatch. Do not attempt to detach the check wire from the lug of the leading edge of the hatch.

GENERAL CARGO TERMINOLOGY

Bale Space

Internal volume measured to the inside edges of the Spar ceiling, beams, tank top ceiling, and bulkhead stiffeners (spar ceiling is often referred to as cargo battens).

Broken Stowage

Unfilled space between packages, this tends to be greatest when large cases are stowed in the end holds, where the shape of the vessel fines off.

Deadweight Cargo

This cargo measures less than 40 cu.ft per ton (1.2 cu.m per tonne), and freight is paid on the actual weight.

Dunnage

This is material used when stowing cargo to protect it from contact with steelwork, other cargoes, or any possibly damaging influences. Tank tops are usually covered with a double layer of dunnage wood, the bottom layer running athwartships to allow drainage to bilges, and normally being more substantial than the upper layer, e.g. 2 in. x 2 in (see Figure 6.13).

Additional dunnage is soft light wood, dry and free from stains, odour, nails and large splinters. New timber should be free of resin and without the smell of new wood. Materials also used for similar purpose are matting, bamboo or waterproof paper.

Grain Space

This is the total internal volume of the compartment, measured from the shell plating either side and from the tank top to underdeck. This measurement is used for any form of bulk cargo that could completely fill the space, an allowance being made for space occupied by beams and frames.

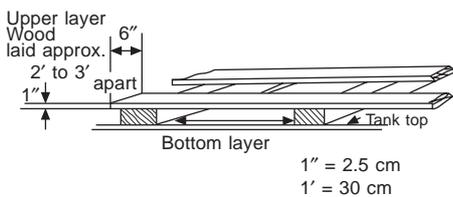


Figure 6.13 Use of dunnage.

Measurement Cargo

This is cargo measuring 40 cu.ft per ton (1.2 cu.m per tonne) or more. The standard is used for comparatively light cargo on which freight is paid on space occupied.

Stowage Factor

The volume occupied by unit weight, this is usually expressed in cu.ft/ton or cu.m/tonne, no account being taken of broken stowage.

DUTIES OF JUNIOR CARGO OFFICER

1. Usually taking responsibility for either the forward or after holds.
2. Before cargo work begins, he should see that the spar ceiling is in good order and in place, that holds and bilges have been cleaned out, and that scuppers and bilge suctions have been tested.
3. Ensuring sufficient clean dunnage is allocated to each hold.
4. Checking that all cargo-handling gear is in correct working order and correctly rigged.
5. Seeing that hold lighting is checked, and seen to be in good order.
6. Checking fire-smothering equipment.
7. Having 'tween-deck guard rails rigged, if necessary.
8. With conventional hatches, ensuring that any unshipped hatch beams are secured against accidental dislodging.
9. Making hatch tents or other equivalent covering readily available at short notice in the advent of bad weather.
10. Regularly checking on the holds to ensure that the cargo is handled and stowed correctly, and on loading to ensure that adequate dunnage is being used in a correct manner.
11. When discharging, searching the hold to ensure that no cargo is left behind, which could lead to overcarriage.
12. Noting all times of starting and finishing cargo operations in the deck log book, together with times of any stoppages.
13. Keeping a rough cargo plan showing cargo lots and their distribution, together with port of destination, tonnage and general particulars.
14. Noting all damaged parcels of cargo when loading. Any damaged parcels found on discharge should be landed in a safe place, and agents and chief officer informed.
15. Ensuring hatchways are secured at the end of each working day.
16. Constantly watching for pilferage throughout all cargo operations.
17. Ensuring ban on smoking is observed in the holds and on the deck areas.
18. Tallying special cargoes, such as mail, bullion etc. and providing lock-up stowage.
19. Stowing dangerous cargo in accordance with the requirements of the 'IMDG code' and/or IMO regulations.
20. Separating cargo of similar nature but for different ports by separation cloths, paint or other appropriate separation mode.

21. Visiting transit shed ashore periodically to inspect stowage and correct handling of cargo.
22. Seeing that fire precautions are observed throughout cargo operations.

HOLD PREPARATION

1. The compartment should be swept clean, and all traces of the previous cargo removed. The amount of cleaning is dependent on the nature of the previous cargo: some cargoes, such as coal, will require the holds to be washed before the carriage of a general cargo. Washing is always carried out after the compartment has been swept. Drying time for washed compartments must be allowed for, before loading the next cargo; this time will vary with the climate, but two to three days must be expected.
2. Bilge areas should be cleaned and all 'bilge suctions' seen to be working satisfactorily. All 'holes' in rose boxes should be clear to allow the passage of water and the lines' non-return valves seen to be in a working condition. Should the bilges be contaminated from odorous cargoes, it may become necessary to 'sweeten' them by a wash of chloride of lime. This acts as a disinfectant as well as providing a coating against corrosion.
3. The fire/smoke detection system should be tested and seen to function correctly.
4. The holds drainage system and 'tween deck scuppers should be clear and free from blockage.
5. Spar ceiling (cargo battens) should be examined and seen to be in a good state of repair.
6. Hatch boards (conventional hatch) should fit correctly and be in a good condition. Steel hatch covers should be inspected for their watertight integrity about any joints. If hard rubber seals are fitted, these should be inspected for deterioration.
7. Tarpaulins, if employed, should provide ample coverage and be of good quality.
8. Hold fittings such as built-in lighting and guard rails should be checked and seen to be in good order.
9. Soiled dunnage should be disposed of. New dunnage, clean and dry, should be laid in a manner to suit the next cargo, if needed.
10. Hold ventilation system should be operated to check fan conditions.

Additional for Special Cargoes

1. *Grain.* Limber boards should be plugged and covered with burlap. This prevents grain blocking bilge suctions, while at the same time allowing the passage of water.
2. *Coal.* Spar ceiling should be removed and covered (most bulk cargoes require this).
3. *Salt.* Metalwork should be whitewashed.

STOWAGE METHODS

Bagged Cargo (paper bags)

These should be stowed on double dunnage. Ideally the first layer should be stowed athwartships on vessels equipped with side bilge systems. Steelwork should be covered by brown paper or matting to prevent bags making contact. Torn bags should be refused on loading. Canvas rope slings should be made up in the hatchway centre to avoid dragging and bursting bags. Hooks should never be used with paper bag cargoes. When stowing, bag on bag stow is good for ventilation, whereas bag on half bag is poor for ventilation but good for economical use of space.

Barrels

Stowed 'bung' uppermost on wood beds, in a fore and aft direction. 'Quoins' are used to prevent movement of the cargo when the vessel is in a seaway. Barrels should never be stowed more than eight high.

Coal (bulk)

Check that bilge suction pumps are in working order and that limber boards are tight fitting. Remove all spar ceiling, stow in the 'tween deck, and cover with a tarpaulin or other similar protection. Plug 'tween deck scuppers. Remove all dunnage and make arrangements for obtaining temperatures at all levels if engaged on a long voyage. Ensure that the coal levels are well trimmed and provide the compartment with surface ventilation whenever weather conditions permit.

Copra

As it is liable to spontaneous combustion, it should be kept dry and clear of steelwork surfaces, which are liable to sweat. Copra beetle will get into any other cargoes which are stowed in the same compartment.

Cotton

Bales are liable to spontaneous combustion, so that the hold must be dry and clean, free of oil stains etc. Adequate dunnage should be laid and all steelwork covered to prevent contact with cargo. Wet and damaged bales should be rejected at the loading port.

Hoses and fire appliances should be on hand and readily available during the periods of loading, fire wires being rigged fore and aft.

Edible Oils

Deep tank stow, for which the tank must be thoroughly cleaned, inspected, and a certificate issued.

Heating coils will be required, and these should be tested during the period of preparation of the space. All inlets and outlets from the tank should be blanked off. Shippers' instructions with regard to carriage temperatures should be strictly adhered to. A cargo log of these temperatures should be kept. Extreme care should be taken on loading to leave enough

'ullage' for expansion of the oil during passage. Overheating should never be allowed to occur, as damage to the oil will result.

Flour

Susceptible to damage from moisture or by tainting from other cargoes, it should never be stowed with fruit, new timber or grain. Should a fire occur during passage, 'dust explosions' are liable from this cargo.

Fruit

Usually carried in refrigerated spaces, especially over long sea passages, it may also be carried chilled under forced ventilation. However, regular checks should be made on ventilation system and compartment temperatures. This cargo gives off CO₂ and will consequently require careful ventilation throughout the voyage.

Glass (Crates)

Crates of glass should never be stowed flat, but on their edge, on level deck space. Plate glass should be stowed athwartships and window glass in the fore and aft line, each crate being well secured by chocks to prevent movement when the vessel is at sea. Overstowing by other cargoes should be avoided.

Vehicles

These should be stowed in the fore and aft line, on level deck space. They should be well secured against pitching and rolling of the vessel by rope lashings. Fuel tanks should be nearly empty. Close inspection should be made at the point of loading, any damage being noted on acceptance.

CARGO HANDLING

Use of Snotters

Rope or wire snotters are in common use when general cargo is discharged. Wire snotters are probably the most widely used, but care should be taken that when using them as illustrated in Figure 6.14, the wire is not allowed to slip along the surface of the steel. This possibility can be eliminated by spreading the area of pressure by inserting a dunnage piece between wire and cargo. Snotters should be secured on alternate sides, passing eye through eye to provide stability to the load.

Use of the Bale Sling Strop

A bale sling strop is more commonly known as a sling or even just a rope strop. It is an endless piece of rope whose ends have been joined by a short splice, used extensively for the slinging of cases or bales, hence its full title (see Figure 6.15).

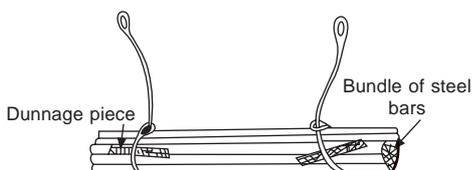


Figure 6.14 Use of snotters.

Palletisation

This is a most convenient pre-package cargo-handling technique (Figure

6.16). Separate slings of cargo are made up before the vessel berths, which speeds up turnaround time, so saving the shipowner considerable port costs. The cargo is generally stacked on wood pallets, which allows easy handling by the use of fork lift trucks. The upper layer of cargo packages are often banded or the full load may be covered by protective polythene. This securing acts as a stabilising factor when the load is being hoisted, as well as an anti-theft device while the pallet is being loaded, stowed or discharged.

The slings are usually made of steel wire rope, having four legs secured to a lifting ring. Each pair of wire slings holds a steel lifting bar, which is used to lift the ends of the pallet and its cargo.

Each load is usually squared off, to reduce broken stowage within the hold, especially so when the vessels are of a flush deck and square corner construction. The pallets cause a certain amount of broken stowage, but this has become an acceptable factor compared to costs of lengthy handling procedures.

Cargo Nets

Fibre rope cargo nets (Figure 6.17) are in general use throughout the marine industry and are extensively used for such cargoes as mail bags, personal effects etc. where the extra strength and wear resistance of a wire rope net is not required.

Wire rope cargo nets are designed for longer life, and are stouter than fibre nets. They carry a bigger load with greater safety, and tend not to distort under the most difficult conditions.

Fibre rope nets are generally of a knotted mesh, but may be woven. The mesh of a wire rope net will contain a specially designed clip at every cross, to provide reinforcement for the net as well as protecting the wire from wear.

Timber Dogs

Timber dogs are used purely for the lifting of heavy logs. The weight of the log causes the sharpened dogs to exercise an even greater grip when inserted into the grain end of the timber. Extreme caution should be observed with this method of lifting, to ensure that the point of the dog is well embedded before starting the lift (see Figure 6.18).

Plate Clamps

If the construction of the plate will permit this method of lifting, then it should be employed. Whether or not the construction of the plate structure lends itself to the use of shackles and slings, or to plate clamps, only one plate should be lifted at any one time.

When lifting with plate clamps (Figure 6.19), loads must not exceed the marked capacity of the clamp, and the jaws must be as narrow as possible for the plate thickness. Before lifting the plate, it should be checked to ensure that it is properly gripped, and under no circumstances should packing be used between the jaws and the plate. When two

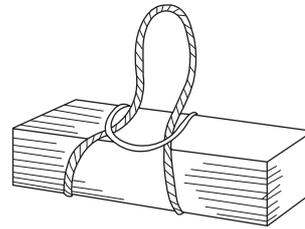


Figure 6.15 Use of bale sling stop.

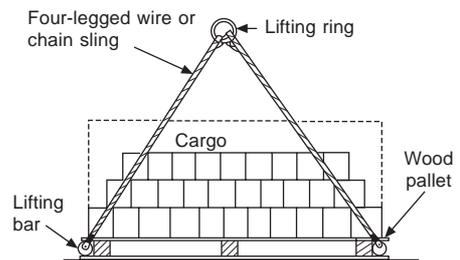


Figure 6.16 Use of pallets.

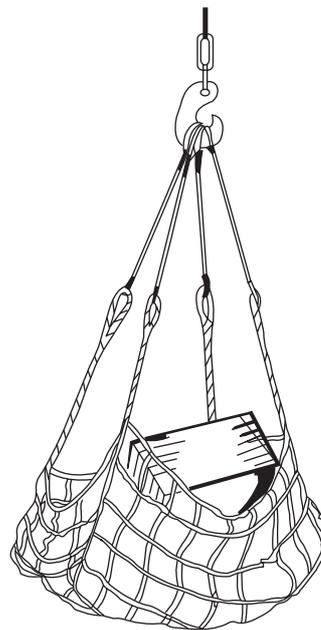


Figure 6.17 Cargo nets.



Figure 6.18 Timber dogs.

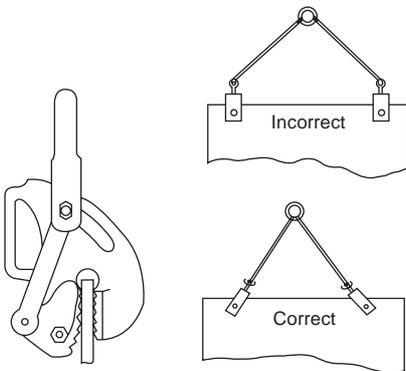


Figure 6.19 Use of plate clamps.

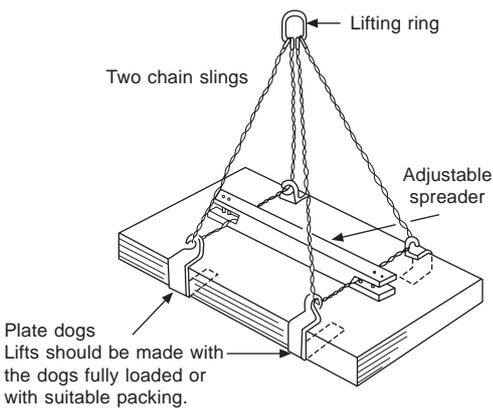


Figure 6.20 Use of plate dogs.

clamps are to be used, they should be inclined and secured in the line of the sling, once the slack has been taken out of the slings.

Slinging Sheet Metal

In this operation plate dogs (Figure 6.20) or can hooks (Figure 6.21) can be used. They are based on a similar holding operation, where the hooks or dogs are tensioned together by a single chain sling (per pair) drawing them tight about the load. The purpose of the adjustable spreader (Figure 6.20) is to prevent the two slings closing up and disturbing the stability of the load.

Use of Chain Slings

Chain slings (Figure 6.22) are used for such heavy types of load as metal castings. Extreme care should be observed with any load, but even more so with a heavy lift, especially if chain slings are employed. There is a tendency for links in the sling to kink inside each other, and if the sling is pulled clear, the links or any kinks in the chain could cause the load to tip, with possible dangerous consequences. It should be remembered that a kink in a chain is a severe weakening factor and should be avoided at all costs.

Timber bearers to provide a clear for the sling to be safely released should be used when landing loads of this nature.

VENTILATION

Natural

This is the most common form of ventilation when cowls (Figure 6.23) are trimmed into the wind to take in outside air, and trimmed back to wind to allow the air circulation an exit from the hold. Fans may be incorporated into this cowl ventilator system especially for the lower hold regions where fans assist delivery and air extractors assist the exhaust system. Cowls may also be fitted with manually operated closure flaps.

Forced

More recent developments in ventilating systems have led to air being pre-dried before entering the hold. In some cases the temperature of the air as well as its humidity may be controlled before entering the compartment (Figure 6.24). This artificial or forced ventilation, has become increasingly popular because, when properly used, it can almost prevent any sweat damage to cargo.

REFRIGERATED CARGOES

Refrigerated cargoes include meat carcasses, carton (packed) meat, fruit, cheese, butter, fish and offal. Ships are specifically designed for their carriage, with separate spaces in holds and 'tween decks, each fitted with suitable insulation and individual control of ventilation. Ordinary general cargoes may be carried in the spaces at other times, the temperature being regulated accordingly for the type of cargo being carried.

Insulation around a compartment consists of either a fibreglass or polystyrene type of packing over the steelwork of the vessel, with an aluminium alloy facing. This insulation is comparatively fragile and requires regular inspection and maintenance.

Cooling a compartment on modern vessels is achieved by circulating pre-cooled air by means of fans. The air is cooled by an ordinary refrigeration plant employing a refrigerant with the most practical qualities, namely, a high thermodynamic efficiency, low costs, low working pressure, low volume non-toxicity, non-inflammability, non-explosivity and ready availability from numerous sources.

Typical Refrigerants

Carbon dioxide (CO₂). Non-poisonous, odourless, with no corrosive action on metal. It has a low boiling point but a high saturated pressure.

Ammonia (NH₃). Poisonous vapour, and therefore requires a separate compartment of its own. It will corrode certain metals, e.g. copper. Has a lower saturated pressure than CO₂.

Freon (CCl₂F₂). Non-poisonous, non-corrosive, and has a low saturated pressure. By far the most popular in modern tonnage.

An older style of reefer vessel had banks of brine-carrying pipes fitted about the cargo compartment, but these are becoming increasingly rare with the more up-to-date technology.

Properties of a Good Insulating Material

1. *Odour*. All material used should be odourless to prevent tainting of cargoes.
2. *Vermin*. The material should be of such a nature, or so treated, that it will not harbour vermin.
3. *Moisture*. The material should not readily absorb moisture.

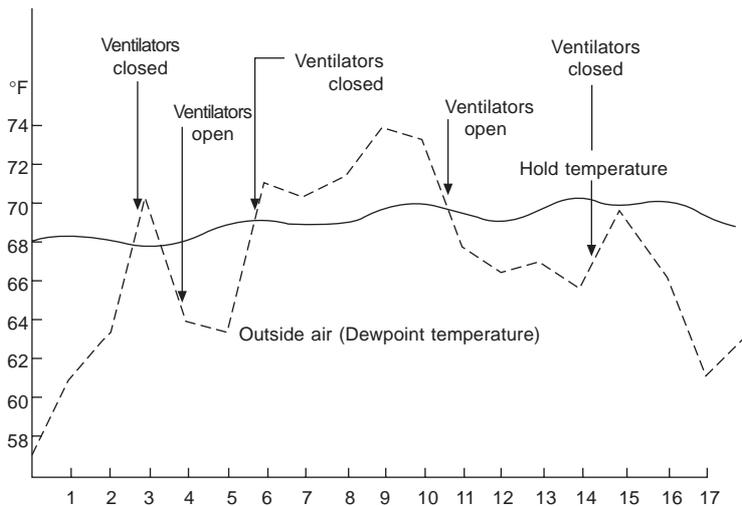


Figure 6.24 Hold temperature and outside Dewpoint temperature graph.

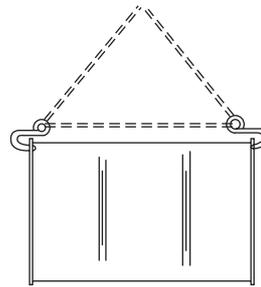


Figure 6.21 Use of can hooks.

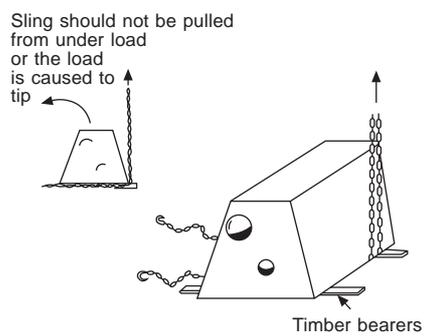


Figure 6.22 Use of chain slings.

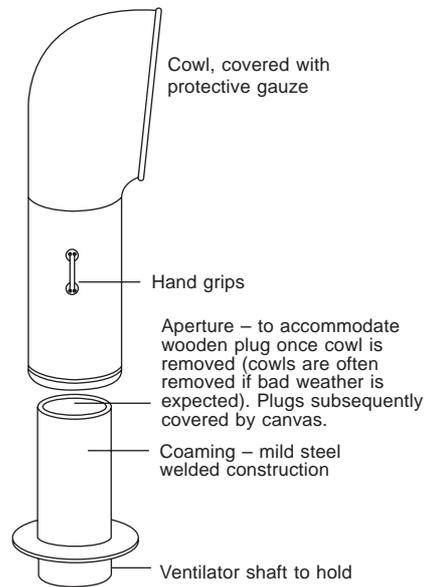


Figure 6.23 Cowl ventilators.

4. *Fire.* Insulation material should be non-combustible, if possible, but at least fire-resistant.
5. *Cost.* The financial outlay must be considered in view of the quantity of material required.
6. *Weight.* Not as important as one might think for merchant vessels; however, for ports with shallow water this would become a factor for consideration.
7. *Maintenance.* Costs of installing and of maintaining the insulation in good condition should be considered at the building/fitting-out stage.
8. *Settling.* Value of the material is lost if, after settling, the air pockets left will necessitate repacking.
9. *Durability.* Must be considered in comparison to the life of the vessel.
10. *Strength.* A great advantage would be if the material was of such quality as to withstand impact when loading or discharging.

Loading

Absolute cleanliness is required during the loading of refrigerated cargo, and the following points should be observed:

1. The compartment should be cleaned of all debris and previous cargo.
2. The deck should be scrubbed and the bulkheads and deck wiped with a light disinfectant.
3. All bilges must be cleaned and bilge suctions tested.
4. 'Tween deck scuppers must be tested, together with all 'U' brine traps.
5. Bilge plugs should be inspected and sealed. Cover plug over bilge suction may be left off for the purpose of survey.
6. Fans must be checked for direction of air flow.
7. Bare steelwork must be insulated.
8. All odours must be cleared from the compartment.
9. All outside ventilation must be shut down.
10. Pre-cooling of the compartment must take place before the cargo is received, times being noted in the cargo log or deck log book.
11. Before loading, the compartment should be surveyed. The surveyors' comments together with the opening temperature of the chamber should be recorded in the mate's deck log book.

Any dunnage required for the cargo should be of a similar standard of cleanliness as that of the compartment. All slings, chains etc. should also be clean and pre-cooled in advance of cargo reception.

CARRIAGE OF GOODS IN DEEP TANKS

Deep tanks are cargo compartments that may be used for the carriage of dry or liquid cargoes. They are usually found in dry cargo vessels at the bottom of one of the holds, forming what would normally be the lower hold portion of the hatch. Some vessels were built with deep tanks either

side of the shaft tunnel (three-island type vessels), where they ran from the midships machinery space, aft.

The openings into the tank are as follows:

1. Main lid.
2. Manhole entrance.
3. Ventilator trunkings.
4. Sounding pipe (usually in the hat box or well).
5. Ullage pipes.
6. Bilge suction line (into the hat box or well).
7. Ballast line.
8. CO₂ or steam smothering line (not always fitted).
9. Steam inlet pipes for heating coils.

When the tank is to be used for dry cargo, the following actions should be carried out before loading the cargo:

- (a) Open CO₂ or steam smothering lines, if fitted.
- (b) Blank off ballast line.
- (c) Check bilge suction and leave the bilge line open.
- (d) Blank off steam inlet to heating coils. Coils may sometimes be removed.
- (e) Open or close ventilator trunks, as required.

When the tanks is to be used for liquid ballast, the following actions are necessary:

- (a) CO₂ or steam smothering lines should be blanked off.
- (b) Bilge line opened.
- (c) Steam inlet to heating coils sealed off.
- (d) Ventilator trunks opened.
- (e) Ballast bend fitted.
- (f) Main lid hard rubber packing should be inspected and checked for deterioration. If found in good condition, the locking bolts should be seen to be well screwed down to obtain even pressure on the seal. Manholes should be treated in a similar manner.

Preparation of Deep Tanks to Receive Liquid Cargo

Tanks must be tested by a head of water equal to the maximum to which the tank may be subjected, but not less than 2.44 m above the crown of the tank. The rubber seal should be inspected for any signs of deterioration about the perimeter of the main lid. Any rubber gaskets about the inspection manholes should be seen to be in good order and to make a good air/water seal.

After the tank has been tested, it should be thoroughly cleaned and sealed. No rust spots or oil patches etc. should be visible. Hat boxes and wells should be meticulously cleaned and sealed off, and ballast and CO₂ lines blanked off. Pressure valves should be fitted into ventilators and the steam coils fitted and tested.

Once all preparations have been completed, the tank must be inspected by a surveyor before loading and a certificate of the tank's condition will be issued.

TABLE 6.1 Cargoes carried in deep tanks

<i>Product</i>	<i>Specific gravity</i>	<i>Cu.ft per tonne</i>
Coconut oil	0.925–0.931	38.8
Palm oil	0.920–0.926	38.9
Palm nut	0.952	37.5
Tallow	0.911–0.915	39.4
Whale oil	0.880–0.884	40.76

CONTAINER TONNAGE

The container is probably the most common unit load system in operation today. The introduction of standard size containers took place in the late 1950s, and the container trade has flourished ever since. Most cargoes are shipped in container form, including heavy steel and liquids. Suitable refrigerated containers may also be used for the carriage of frozen and chilled foodstuffs, their plant power supply being connected to the vessel's main electrical source.

Containers of all sizes are generally loaded by a shore side gantry crane, travelling the length of the quay on trackways. These cranes are usually equipped with automatically controlled lifting mechanisms to facilitate the lifting and loading of units. The jib section of the gantry crane being lowered from the stowed elevated position after the vessel has berthed alongside.

It would appear that in container operations one of the more sensitive areas for accidents to ships' personnel is ashore in the container stowage area. Straddle trucks, often referred to as elephant trucks, used for the transportation of containers from the park to the gantry crane, are driven by drivers in a highly elevated position. The field of view is somewhat restricted by the structure of the trucks, making the area extremely dangerous for unauthorised personnel.

The disadvantage of the container trade is that an empty container with no load to refill it becomes a liability, left at the wrong end of the trade route. Consequently, the majority of container designed vessels will at some part of the voyage carry to and fro some empty units. This means a limited loss of revenue to the shipowner, though a necessity for the continuation of the operation.

Ship's officers should be aware that containers should be loaded in an even manner, both athwartships and fore and aft, to maintain the stability of the vessel. Not all containers are in a fully loaded condition, so that the centre of gravity of the containers will vary. This will affect the final centre of gravity of the vessel on completion. The problem is that unless each container is opened up on loading, the ship's personnel have only the shore authorities' word with respect to the weight and CG of the container. However, it should be remembered that most container terminals have means (weigh bridge) of checking container weights.

ROLL ON–ROLL OFF SYSTEM

Roll on–roll off (Ro Ro) methods of handling cargo have developed



24. Roll on–Roll off unit container cargo being loaded over stern ramp of modern ferry vessel

from the original container idea of a door-to-door service for the shipping customer. The concept is based on a quick turnround, making the delivery not only fast and efficient but very economical. A larger type of vessel has recently been constructed for the more lengthy voyage, with the combined rapid turnround producing high yield profits.

Roll on–roll off ships are usually built with extensive fire-prevention systems, including total CO₂ flooding to all garage spaces, automatic sprinkler and/or water curtains, usually a foam installation, together with conventional water hydrants. Fire precautions are maintained to a high degree, with no smoking on vehicle decks, private cars to have limited fuel in tanks etc. Regular drills and fire patrols are maintained, and a smoke-detection system must be employed.

Construction of this type of vessel usually includes such special features as longitudinally strengthened decks, clear of obstructions such as pillars and spar ceiling; a forced ventilation fan system for the purpose of clearing exhaust fumes; internal ramps to upper decks and/or cargo lifts (electro/hydraulic) to lower levels; and a bow visor (Figure 6.25) with vehicle ramps fore and aft, allowing access into main garage areas. Built-in overhead lighting, welded struts for tyre grips, and anti-roll ship stabilisers are also regular features of the Ro Ro trade.

Securing Methods

All unit loads are disengaged from the loading tugmaster and secured by a minimum of six chain lashings (40 ft unit). Additional lashings would be secured to heavier or longer/wider loads. Each chain lashing is tensioned and locked by a bar lever or loadbinder. Various ports have their own systems: for example some ports do not cross the end lashings on units but leave them just in the fore and aft line (see Figure 6.26).

Lashings are secured to the deck in 'star insert' or 'star dome' securing points. A club foot is locked into the point while the other end of the lashing hooks on to the lugs of the unit. The star insert points are flush to the deck and are preferable to the raised dome securing points, which is illustrated.

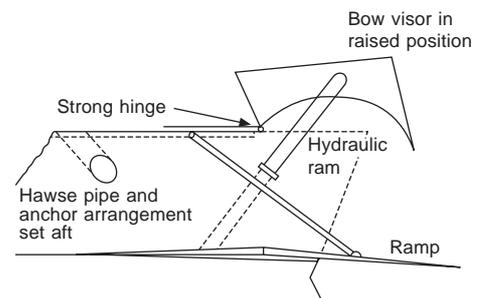


Figure 6.25 Visor type – bow door and ramp. All openings are usually above the waterline and the door is kept watertight by hard rubber packing and hydraulic pressure on closing.

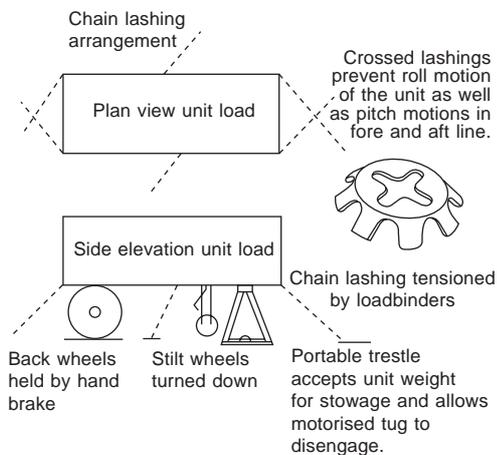


Figure 6.26 Ro Ro securing methods.

CARGO PLANS

General Cargo Vessels

A ship's cargo plan shows the distribution as well as the disposition of all parcels of cargo aboard the vessel. The plan is formulated usually from the workbooks of the 'deck officers', a fair copy being produced before departure from the final port of loading. This allows copies of the plan to be made before the vessel sails. The copies are forwarded to agents at ports of discharge to allow the booking and reservation of labour, as appropriate.

The cargo plan should include relevant details of cargoes, i.e. total quantity, description of package, bales, pallets etc., tonnage, port of discharge, identification marks and special features if and when separated. The port of discharge is normally 'highlighted' in one specific colour, reducing the likelihood of a parcel of cargo being overcarried to the next port. Cargoes which may have an optional port of discharge are often double-coloured to the requirements of both ports.

The plan should be as comprehensive as space allows. Consequently, abbreviations are a common feature, e.g. Liverpool as L'pool, 500 tonnes as 500t, cartons as ctns, cases as c/s, and heavy lift 120 tonnes as H/L, 120t.

Additional information, such as the following, generally appears on most plans:

- Name of the vessel.
- Name of the Master.
- List of loading ports.
- List of discharging ports, in order of call.
- Sailing draughts.
- Tonnage load breakdown.
- Hatch tonnage breakdown.
- Voyage number.
- Total volume of empty space remaining.
- List of dangerous cargo, if any.
- List of special cargo, if any.
- Statement of deadweight, fuel, stores, water etc.
- Details of cargo separations.
- Recommended temperatures for the carriage of various goods.
- Chief officer's signature.

The plan provides at a glance the distribution of the cargo and shows possible access to it in the event of fire or the cargo shifting. Its most common function is to limit overcarriage and the possibility of short delivery at the port of discharge. It also allows cargo operations, stevedores, rigging equipment, lifting gear and so on to be organised without costly delays to the ship.

Tankers

Tanker cargo plans are constructed on the same principle as plans for general cargo ships. However, by the very nature of the cargo, it is only

necessary to show disposition of the tank cargoes at one level. The plan proves especially useful when a number of differing grades or types of cargoes are to be loaded.

The plan should contain relevant information for the loading/discharge officer and should include the following:

Grade of liquid.

Weight of cargo in the tank.

The ullage of the tank.

Volume and relative density at a specific temperature.

The carriage temperature.

Slack tanks' identification.

Empty tanks' identification.

Loaded draughts.

Deadweight.

Tonnage load breakdown.

Chief officer's signature.

Colour schemes are employed usually to highlight the grade of cargo, the danger from contamination being greater than that from overstowage and overcarriage of cargo. It is not uncommon to see pipelines overprinted on the plan, enabling cargo officers to see clearly which lines are to be used for specific parcels of cargoes. This addition also lessens the risk of contamination.



25. Fore end view of tanker vessel at sea pipeline and ventilation arrangements illustrated.

BOATWORK



Author's note: mariners are advised that regulations refer to SOLAS and the IMO publications. Member countries of the International Maritime Organisation may have varying standards affecting their/our fleets imposed by their/our authority, e.g. United Kingdom; Maritime and Coastguard Agency.

General Requirements for Lifeboats

The 1983 amendments to the SOLAS convention of 1974 requires:

1. All lifeboats shall be properly constructed and have ample stability in a seaway with sufficient freeboard when fully loaded with their full complement of persons and equipment. All lifeboats shall have rigid hulls and shall be capable of maintaining positive stability when in an upright position in calm water, fully loaded as described, and holed in any one location below the waterline, assuming no loss of buoyancy material and no other damage.
2. Lifeboats should be of sufficient strength to:
 - (a) enable them to be safely lowered into the water when loaded with their full complement and equipment;
 - (b) be launched and towed when the ship is making headway at a speed of 5 knots in calm water.
3. Hulls and rigid covers shall be fire retardant or non-combustible.
4. Seating shall be provided on thwarts, benches or fixed chairs fitted as low as practicable in the lifeboat and constructed so as to be capable of supporting the number of persons each weighing 100 kg.
5. Each lifeboat shall be of sufficient strength to withstand a load without residual deflection on removal of that load:
 - (a) In the case of boats with metal hulls, 1.25 times the total mass of the lifeboat when loaded with its full complement of persons and equipment.
 - (b) In the case of other boats, twice the total mass of the lifeboat when loaded, as stated.
(Mariners should note that this requirement does not apply to rescue boats.)

6. The strength of each lifeboat when fully loaded and fitted with skates or fenders where applicable, should be capable of withstanding a lateral impact against the ship's side at an impact velocity of at least 3.5 m/s and also a drop into the water from a height of at least 3 m.
7. The vertical distance between the floor surface and the interior of the enclosure or canopy over 50 per cent of the floor area shall be:
 - (a) Not less than 1.3 m for a lifeboat permitted to accommodate nine persons or less.
 - (b) Not less than 1.7 m for a lifeboat permitted to accommodate 24 persons or more.
 - (c) Not less than the distance as determined by linear interpolation between 1.3 and 1.7 m for a lifeboat permitted to accommodate between nine and twenty-four persons.

General Information Regarding Lifeboats

1. *Access into Lifeboats*
 - (a) Every passenger ship lifeboat shall be so arranged that it can be rapidly boarded by its full complement of persons. Rapid disembarkation shall also be possible.
 - (b) Every cargo ship lifeboat shall be so arranged that it can be boarded by its full complement of persons in not more than 3 minutes from the time the instruction to board is given. Rapid disembarkation must also be possible.
 - (c) Lifeboats shall have a boarding ladder that can be used on either side of the lifeboat to enable persons in the water to board. The lowest step of the ladder shall be not less than 0.4 m below the lifeboat's light waterline.
 - (d) The lifeboat shall be so arranged that helpless people can be brought on board either from the sea or on stretchers.
 - (e) All surfaces on which persons might walk shall have a non-skid finish.
2. *Lifeboat Buoyancy*

All lifeboats shall have inherent buoyancy or shall be fitted with inherently buoyant material which shall not be adversely affected by seawater, oil or oil products, sufficient to float the lifeboat with all its equipment onboard when flooded and open to the sea. Additional inherent buoyancy material equal to 280 N of buoyant force per person shall be provided for the number of persons the lifeboat is permitted to accommodate. Buoyant material, unless in addition to that required above, shall not be installed external to the hull of the boat.
3. *Lifeboat Freeboard and Stability*

All lifeboats, when loaded with 50 per cent of the number of persons the lifeboat is permitted to accommodate seated in their normal positions to one side of the centre line, shall have a freeboard

measured from the waterline to the lowest opening through which the lifeboat may become flooded, of at least 1.5 per cent of the lifeboats length or 100 mm, whichever is the greater.

4. *Lifeboat Markings*

A lifeboat should be permanently marked with the dimensions of the boat and the number of persons it is permitted to accommodate. The name and port of registry of the ship to which the lifeboat belongs shall be marked on each side of the lifeboat's bow in block capitals of the Roman alphabet. The mark for identifying the ship to which the boat belongs and the number of lifeboat shall be visible from above.

PARTS OF THE LIFEBOAT

The modern lifeboat is normally made of metal or fibreglass, with some wooden internal fitments. The days of all-wood construction have all but disappeared, but the names of the parts of the wooden boat have been handed down to their modern counterparts (see Figure 7.1) and wooden boats will continue to exist for many years worldwide. Lifeboats are illustrated in Plates 26 and 27.

Gunwale Construction

The upper part, previously referred to as the gunwale capping, was a fore and aft member which provided additional strength and protection

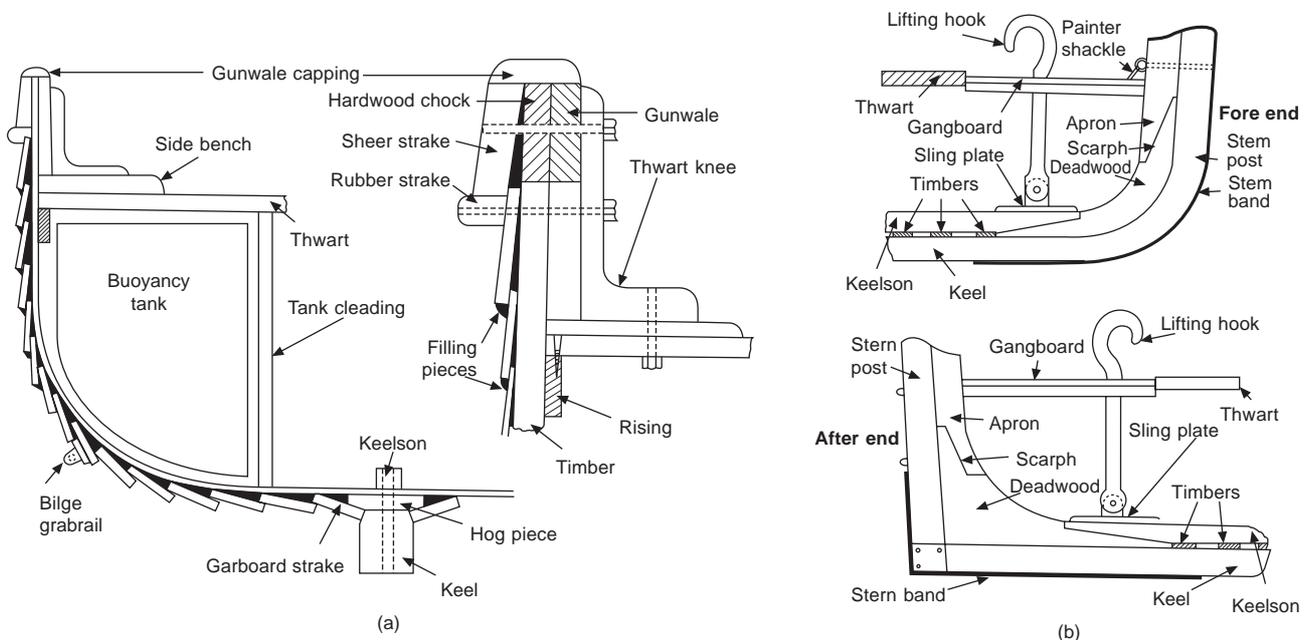
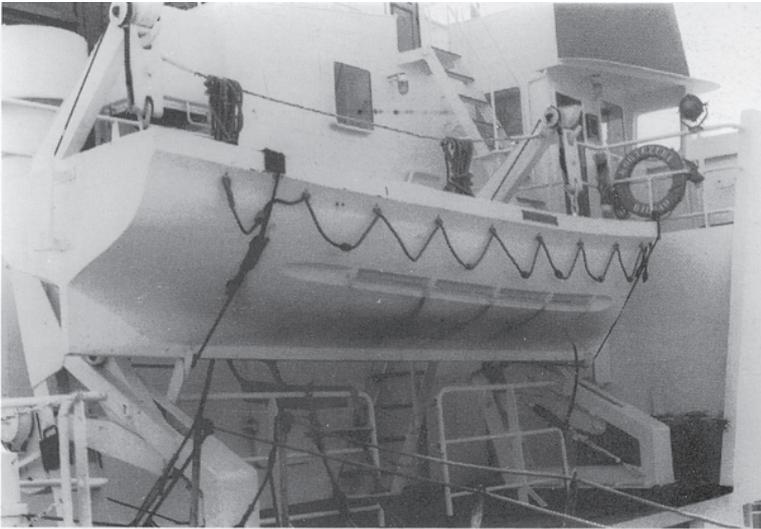


Figure 7.1 (a) Wooden boat construction, (b) bow and stern cross section.



26. Open boat in gravity davits. Transom stern, davit span with lifelines, becketed lifeline and gripes clearly indicated.

to the gunwale itself and the sheer strake. It was pierced at regular intervals to accommodate the crutches, or cut away when rowlocks were fitted.

The gunwale was a strength member running in a fore and aft direction and backed by a hard wooden chock up to the filler piece and the sheer strake. This build-up has been replaced in modern boats by metal or fibre-glass moulded into a rounded section, so obtaining a prefabricated strength section. The rubber is incorporated on the outside of this section in the early course of manufacture.

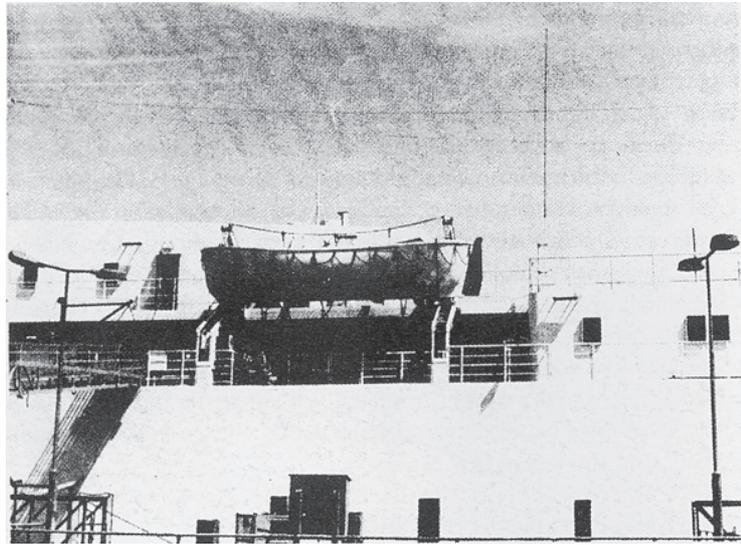
Side benches and thwarts are still manufactured in wood in most cases, and secured by metal knees. The ribs of the old wooden boats, known as timbers, have been rendered obsolete by the increased strength of materials used in modern manufacture; however, the rising, another fore and aft member, is still fitted in most new builds. The rising, previously used to lash the lanyards of the crutches to and support the thwarts, still performs the same function, except that crutches are often on short chains and secured under the gunwale area.

Fore and Aft End Construction

The stem and stern posts, fore and aft, are the most upright components of the boat, and are now generally constructed in metal. When they were made of wood, it was common practice to have a protective stem band of metal over the prow and a wooden apron piece backing inside the boat. The apron was used to secure the planking on either side. New construction is no longer fitted with the apron as such, and the moulded sections are welded or fused directly on to the stem and stern posts.

The bow and stern sheet areas still incorporate lower breast hooks, but these generally form an extension of the side benches. The gangboard is a wood or metal board joining the port and starboard sides of the

27. GRP lifeboat secured in gravity davits. The becketed lifeline around the gunwale is clearly defined, together with the three keel grablines, and the embarkation boarding ladder in the stowed position under the boat.



breast hook, together with the stem and stern bars, to the forward and aftermost thwarts. The lifting hook passes up through the gangboard.

Fitments will vary from boat to boat but the majority are supplied with a ring bolt or eye on the inside of the stem post to facilitate securing the permanent painter. They also have a fairlead sited on the gunwale for use with the sea anchor.

Internal Construction

The *keel* of the more modern boat is made of metal or reinforced glass fibre section. Running in the fore and aft line, it forms a natural extension between the stem and stern posts. The athwartships strength, previously provided as timbers, is now obtained by metal ribs welded or riveted from the keel up to the gunwale. These ribs still retain the term 'timbers', but as they are manufactured, if fitted, in metal, the term must be technically incorrect. They are not as frequent as the old wooden timbers used to be, because additional strength is obtained by the use of metal instead of wood.

Covering the keel and the timbers are the wood bottom boards of the boat, providing a safe walking area. When movement about the boat becomes necessary, then safety for the boat and the individual is improved by walking on the bottom boards. It is bad practice to step on the thwarts, and once on board, persons should endeavour to lower the centre of gravity of the boat by keeping their own weight as low as possible. The bottom boards generally tend to be secured in between the sides of the buoyancy tanks, which are positioned hard up against the outer hull on either side of the boat.

The number of thwarts in the boat will be determined by the boat's length. They not only provide the seating within the boat but also act as athwartship strength members, tying the upper sides of the boat together.

Similarly the side benches, used to seat survivors in a crowded boat, also act as stringers, strengthening the upper parts of the boat in the fore and aft line. It should be noted that circumstances may dictate the use of the bottom boards as seats: for example, when beaching a lifeboat.

Additional fitments may come in the form of wood stretchers for use by crew members when rowing: these are often adjustable for the length of leg of the individual and when not in use, as when sailing, they may be removed altogether. Another fitment, which is often portable, is the mast thwart, which provides a clamping arrangement for securing the mast in the vertical when sailing. Most lifeboats have a mast step or tabernacle over the keel to accept the heel of the mast, while the body of the mast is clamped against the thwart approximately 3 ft above the keel. Rigidity in the mast is afforded by these two securing points, the shrouds to port and starboard, and the forestay, if fitted.

TYPES OF WOOD CONSTRUCTION

Carvel

In this form (Figure 7.2) the planks are laid end on to each other, as opposed to the overlapping of clinker construction. A flush finish is obtained by caulking between the joins of the planks where they butt together. Not the most stable or the strongest build of boat, it is nevertheless tried and tested, and stands considerable wear.

Clinker

This is the most stable of all the builds of wooden boats (Figure 7.2). The planks overlap, providing an anti-roll property and double strength at the joins of the planks. Filler pieces are used to effect a tight fit plank on plank, and copper nails to secure the planks to the timbers. The build is popular for boats under 10 m in length because of the stabilising factor of the overlapping planks.

Water resistance to the hull is extensive and the speed attained by the boat under the same conditions would not be the same as that of the carvel-built boat. The clinker is easy to repair, should the outer planks become damaged; a section of the plank is simply removed and replaced, with little of the trouble that it would take to repair a carvel-built boat.

Double-Diagonal

This is the strongest of the wooden-built boats and the most expensive (Figure 7.3). It is double planking laid diagonally from the keel, forming a double skin effect. Two layers of strakes are laid in the direction of opposing diagonals, with a layer of calico or canvas between the plank layers. This flax skin is usually glued to the inner skin and painted, providing a waterproof seal in its own right. The outer layer of planking is butted edge to edge so as to give a carvel effect, reducing water frictional resistance.

This build of boat was used where additional strength was required,

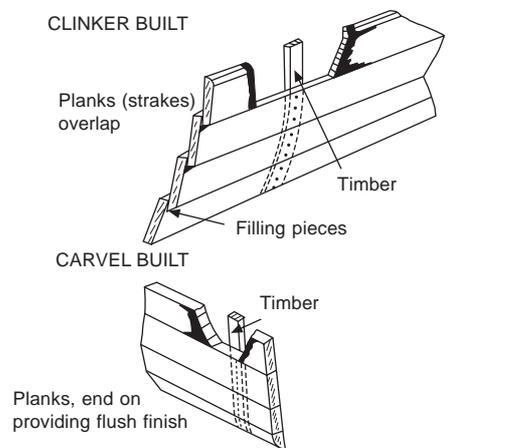


Figure 7.2 Clinker and carvel building. Planks are secured to timbers by the use of copper or similar type nails. Watertightness is achieved by the use of washers, known as 'roves', for each nail.

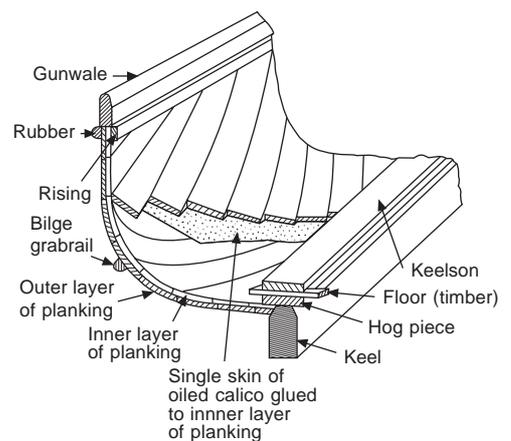


Figure 7.3 Carvel double-diagonal building.

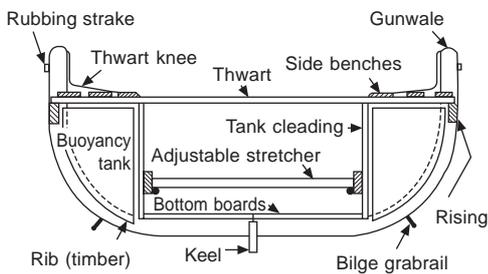


Figure 7.4 Cross-section of modern lifeboat.

as with air/sea rescue craft. Economic reasons alone have restricted its use and the expertise in building this type of hull is becoming a thing of the past. Modern methods of obtaining strength in construction are by the use of glass fibre, with, in some cases, the incorporation of a wooden framework in the early stages of building.

BOAT FITMENTS

A cross-section of a modern lifeboat appears in Figure 7.4.

Bilge Grabrail

Made either of metal or wood, this rail is fitted at the turn of the bilge on the outside of the boat's hull. Its length will vary but is approximately two-thirds of the boat's length. Its purpose is to provide a handhold for persons in the water, and it would without doubt provide a useful footrest if trying to right a capsized boat.

Buoyancy Chambers

These are sealed air tanks, fitted under the side benches, providing the internal buoyancy of the boat. They are held in position by a wooden supporting frame called the 'tank cleading'. The total volume of the chambers should be equal to at least one-tenth of the volume of the boat.

They are manufactured from non-corrosive metals such as copper or galvanised steel. Copper and brass are expensive, so that the galvanised metals are more popular today. The chambers are often coated with varnish or boiled linseed oil to protect them from corrosion.

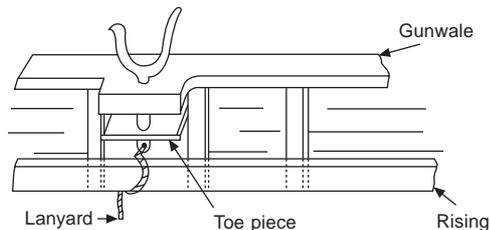


Figure 7.5 Crutch.

Crutches

The crutch (Figure 7.5) is a metal 'U'-shaped support to accommodate the loom/shaft of the oar when rowing. A metal pin supports the 'U' and the pin is fitted into a socket set into the gunwale. To prevent loss, each crutch is secured by a lanyard to a fore and aft member of the boat, e.g. stringer or rising. The crutches are positioned just aft of the pulling thwarts to give crew members comfortable pulling positions.

Lifting Hooks

Normally these are single hooks at each end of the boat, facing inwards, to accommodate the blocks of the falls. Some boats in passenger vessels may be fitted with a ramshorn style of lifting hook, but the majority of vessels are equipped with the single lifting hook.

They are secured to a lugged sling plate referred to as a 'keel plate'. This plate in turn is held fast by holding down bolts passing through to the keel. The rigidity to the structure is improved by the metal stem from the hook being supported by a gangboard.

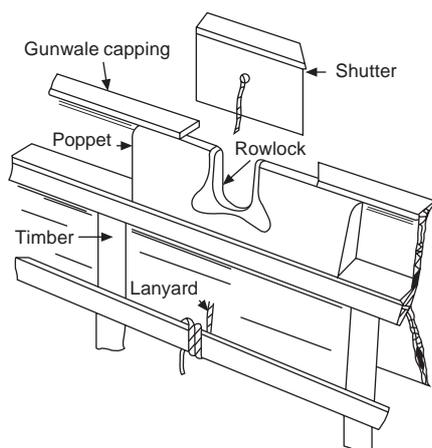


Figure 7.6 Rowlock.

Rowlock

The term rowlock is widely misused in many boating circles for crutch. The rowlock (Figure 7.6) is in fact a cut-away made in the gunwale of

the boat to perform the same function as the crutch, hence the common mistake. Larger builds of boat may have the rowlock cut into a wash strake, set over and above the gunwale. When not in use, as when the boat is sailing, the rowlocks are covered by a shutter/poppet arrangement, so leaving a flush gunwale capping, which prevents the sheets becoming fouled.

Skates

All ship's lifeboats except the emergency boat on passenger vessels are equipped with skates or fenders to help them skid down the ship's side when being launched. The skates are secured on the inboard side of the lifeboat, and perform no function other than assisting the successful launch. To this end, once the vessel has sunk, they may be discarded. However, circumstances may dictate that, after the boat is launched, the possibility of returning to the parent vessel may arise. Should this be the case, then the skates may be required a second time.

They are normally made of wood or metal, and hinged to meet the curved lines of the boat's hull. A wire passing under the keel secures the skate in position on the offshore side of the boat.

(Note: Reference to skates for rescue boats.)

Small Gear Locker

This is a watertight tank containing the food rations and all other small gear carried in the boat. There may be as many as three separate lockers, each clearly labelled and provided with screw sealing lids. Some types of locker are provided with metal keys.

Thole Pins

A single thole pin used in conjunction with a grommet was the old-fashioned method of securing an oar when rowing or sculling. A more popular method today would be to use two thole pins (Figure 7.7) and place the oar in between them. However, even this use of thole pins has become obsolete and they are rarely used in conjunction with oars.

They are, however, usefully employed when the boat is sailing, for crew to take a turn about them with the sheets and halyards. Modern sailing rigs often use miniature thole pins in and about the mast thwart. They are usually made of brass not wood. Heavy wooden thole pins are to be found aboard the larger sailing craft, schooners and the like.

Water Containers

Metal tanks of a non-corrosive nature, water containers are usually sited under the thwarts of the boat. Each tank is fitted with a large filling hole, which is also used, with the dipper, to extract the water.

The water should be frequently changed to ensure that it remains in a 'sweet condition', and to this end a drain plug is fitted to the lower part of each tank. It is common practice to wash out the tank before refilling.

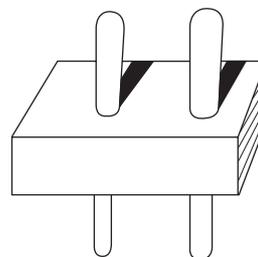


Figure 7.7 Thole pins.

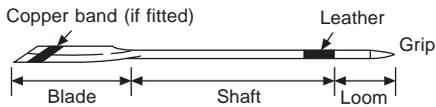


Figure 7.8 Oar.

Standard Lifeboat Equipment

1. Sufficient buoyant oars to make headway in calm seas. Thole pins, crutches or equivalent arrangement shall be provided for each oar provided. Pulling oars are normally between 3.05 and 4.26 m in length (10–14 ft), they are generally made of ash or elm wood, and stowed with their blades facing forward.
A steering oar, which is no longer specified, if carried, is usually approximately (12 in.) 0.3 m longer than the pulling oars. Its blade faces aft and is usually coated in a distinctive colour. It is used extensively to provide additional leverage in order to steady the boat's head when used in conjunction with the sea anchor.
2. Two boat hooks, to be left unlashed and ready for use in fending away from the ship's side.
3. A buoyant bailer and two buckets. These are secured by lanyards to the structure of the boat. Buckets are usually of a 2 gallon size (9 l) and manufactured in galvanised iron or rubber, stowed either end of the boat.
4. A survival manual.
5. Two axes (hatchets) stowed one at each end of the boat. It is common practice to cover the metal head of the axe with a canvas protective cover to prevent the metal from pitting and corrosion.
6. A jack-knife to be kept attached to the boat by a lanyard. The blade normally incorporates a tin opener and screw driver, and a small hand spike is usually attached.
7. Two buoyant rescue quoits, attached to not less than 30 m of buoyant line. These are normally stowed in the small gear locker.
8. Six doses of anti-seasickness medicine and one seasickness bag for each person the boat is permitted to accommodate. The medicine is normally in tablet form.
9. A manual pump. Usually fixed to the structure of the boat. It is fitted with an easily removed cover to allow cleaning and the suction end contains a gauze filter to avoid blockage of the system.
10. A sea anchor of adequate size fitted with shock resistant hawser and a tripping line which provides a firm hand grip when wet. The strength of the hawser and the tripping line shall be adequate for all sea conditions.
11. Four rocket parachute flares, which comply with the regulations.
12. Six hand flares (red) which comply with the regulations.
13. Two buoyant smoke floats (orange) which comply with the regulations.
14. One waterproof electric torch suitable for Morse signalling, together with one spare set of batteries and one spare bulb in a waterproof container.
15. One whistle or equivalent sound signal. Normally of plastic construction of the non-pea design. This will allow its use in cold weather without discomfort to the user.
16. One daylight signalling mirror with instructions for its use for signalling to ships and aircraft (see life raft equipment list for use).

17. An efficient radar reflector.
18. One copy of the life-saving signals table, prescribed by regulation V/16 on a waterproof card or in a waterproof container.
19. Two efficient painters of a length equal to not less than twice the distance from the stowage position of the lifeboat to the waterline in the lightest sea-going condition or 15 m whichever is the greater. One painter attached to the release device, placed at the forward end of the lifeboat, must be capable of being released when under tension. The other painter shall be firmly secured at or near the bow of the lifeboat ready for use.
20. A binnacle containing an efficient compass which is luminous or provided with suitable means of illumination. In a totally enclosed boat the binnacle shall be permanently fitted at the steering position, in any other lifeboat, it shall be provided with suitable mounting arrangements.

When setting up a boat's compass, the mariner should bear in mind that it must be visible to the coxwain and a fore and aft line may have to be set up between the stem and stern to provide reference for means of aligning the boat's head to the lubber line.

21. Sufficient tools to allow minor adjustment to the engine and its accessories.
22. Portable fire extinguishing equipment suitable for extinguishing oil fires.

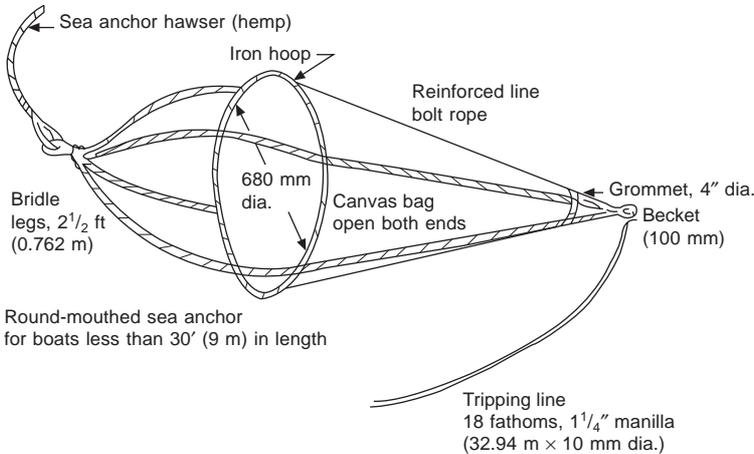


Figure 7.9 Sea anchor.

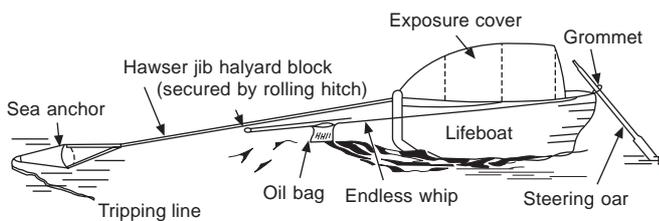


Figure 7.10 Heaving to.

23. A searchlight, capable of effectively illuminating a light coloured object at night having a width of 18 m at a distance of 180 m for a total period of 6 hours and of working continuously for not less than a 3 hour period.
24. Thermal protective aids which comply with the regulations, in sufficient number for 10 per cent of the total number of persons that the boat is permitted to carry.
25. A watertight receptacle containing a total of 3 litres of fresh water for each person the lifeboat is permitted to accommodate. 1 litre of this amount may be replaced by a de-salting apparatus capable of producing an equal amount of fresh water in two days.
26. A rustproof dipper with a lanyard, used for extracting fresh water from the containers. The lanyard should be long enough to reach the bottom of any water tank.
27. A rustproof graduated drinking vessel.
28. Three tin openers.
29. One set of fishing tackle.
30. A food ration totalling not less than 10,000 kJ for each person the lifeboat is permitted to accommodate. These rations shall be kept in airtight packaging and be stowed in a watertight container.
31. A first aid outfit in a waterproof case capable of being closed tightly after use.

All items of equipment of the lifeboat, with the exception of the two boat hooks, should be secured by lashings or kept in storage lockers, or secured by brackets or other similar mounting arrangement. Considerable changes in standard equipment have taken place with the 1983 amendment to the SOLAS convention.

The Sea Anchor

The sea anchor is a cone-shaped canvas bag, open at both ends, one end being much larger than the other (680 mm in diameter). It is usual to stream the sea anchor over the bow when heaving to, allowing the boat to ride head to wind and sea. However, it may be used as a drag effect over the stern when the boat has a following sea and is running before the wind.

To Stream the Sea Anchor

Bring the boat head to wind.
 Down sails and strike the mast. Unship tiller and rudder.
 Rig steering oar, over stern through grommet.
 Stream sea anchor over the bow paying out hawser and tripping line from the same side of the boat, if practical.

Rescue Signal Table

This is a printed plastic instruction card showing the following methods of signalling and attracting attention (Figure 7.11).

IN

Answering signals made by Lifesaving Stations when signals are seen from a ship or a person in distress.

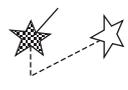
Hand signals	Light signals	Other signals	Meaning
	<p>Orange</p>  <p>Orange smoke signal</p>	 <p>Exploding white star rocket. 3 single signals fired at 1 minute intervals</p>	<p>You are seen Help is coming</p>
	 <p>White star rocket. 3. single signals fired at about 1 minute intervals.</p>		

Landing signals for the guidance of small boats or persons in distress.

Hand signals	Light signals	Other signals	Meaning
 <p>Up and down movement of a white flag, white light or flare, or the arms</p>	<p>Green</p>  <p>Green star</p>	<p>Morse code letter K</p>  <p>Given by light or sound.</p>	<p>Land here</p>

If a second steady flag, light, or flare is shown at a lower level:

Line the two up and come in on this line of approach

 <p>Side to side movement of a white flag, white flare or light, or of the arms fully extended</p>	 <p>Red Red Star</p>	<p>Morse code letter S</p>  <p>Given by light or sound.</p>	<p>Landing dangerous</p>
 <ol style="list-style-type: none"> Side to side movement of a white flag, light, or flare. Placing of flag or light in the ground. Carrying a second flag or light in the direction to be indicated. 	 <ol style="list-style-type: none"> Red star fired vertically and White star fired pointing to a better landing place. 	<p>Morse code letter S followed by . . .</p> <p>(a) R . ——— . if a better landing place is to the right of the direction of approach or</p> <p>(b) L . ——— . . if a better landing place is to the left of approach.</p>	<p>Landing dangerous. Go in direction indicated.</p>

Note: Red and green star signals are no longer used by coastguards in the UK.

Figure 7.11

Lifeboat (Engine) Propulsion

In accordance with the 1983 amendment to the SOLAS convention 1974. Every lifeboat shall be powered by a compression ignition engine. No engine shall be used for any lifeboat if its fuel has a flashpoint, of 43°C or less (closed cup test).

1. The engine shall be provided with either a manual starting system or with a power starting system with two independent rechargeable energy sources. Any necessary starting aids shall also be provided. The engine starting systems and starting aids shall start the engine at an ambient temperature of -15°C within 2 minutes of commencing the start procedure unless, in the opinion of the Authority having regard to the particular voyages in which the ship carrying the lifeboat is constantly engaged, a different temperature is appropriate. The starting systems shall not be impeded by the engine casing, thwarts or other obstructions.
2. The engine shall be capable of operating for not less than 5 minutes after starting from cold with the lifeboat out of the water.
3. The engine shall be capable of operating when the lifeboat is flooded up to the centre line of the crank shaft.
4. The propeller shafting shall be so arranged that the propeller can be disengaged from the engine. Provision shall be made for ahead and astern propulsion of the lifeboat.
5. The exhaust pipe should be so arranged as to prevent water from entering the engine in normal operation.
6. All lifeboats shall be designed with due regard to the safety of persons in the water and to the possibility of damage to the propulsion system by floating debris.
7. The speed of a lifeboat when proceeding ahead in calm water, when loaded with its full complement of persons and equipment and with engine powered auxiliary equipment in operation, shall be at least 6 knots and at least 2 knots when towing a 25 person life raft loaded with its full complement of persons and equipment, or its equivalent. Sufficient fuel, suitable for use throughout the temperature range expected in the area in which the ship operates, shall be provided to run the fully loaded boat at 6 knots for a period of not less than 24 hours.
8. The lifeboat engine transmission and engine accessories shall be enclosed in a fire retardant casing or other suitable arrangements providing similar protection. Such arrangements shall also protect persons from coming into accidental contact with hot or moving parts and protect the engine from exposure to weather and sea. Adequate means shall be provided to reduce noise from the engine. Starter batteries shall be provided with casings which form a watertight enclosure around the bottom and sides of the batteries. The battery casing shall have a tight-fitting top which provides for necessary gas venting.
9. The lifeboat engine and accessories shall be designed to limit

electromagnetic emissions so that the engine operation does not interfere with the operation of radio life-saving appliances used in the lifeboat.

10. Means shall be provided for re-charging all engine-starting, radio, and searchlight batteries. Radio batteries shall not be used to provide power for engine starting. Means shall be provided for re-charging lifeboat batteries from the ships power supply at a supply voltage not exceeding 55 V, which can be disconnected at the lifeboat embarkation station.
11. Water-resistant instructions for starting and operating the engine shall be provided and mounted in a conspicuous place near the engine controls.

Propulsion Requirements for Totally Enclosed Boats

The engine and transmission shall be controlled from the helmsman's position. The engine and its installation shall be capable of running in any position during capsize and continue to run after the lifeboat returns to the upright or shall automatically stop on capsizing and be easily restarted after the lifeboat returns to the upright. The design of the fuel and lubricating systems shall prevent the loss of fuel and the loss of more than 250 ml of lubricating oil from the engine during capsize.

In the case of air-cooled engines, they shall have a duct system to take in cooling air from, and exhaust it to, the outside of the boat. Manually operated dampers shall be provided to enable cooling air to be taken from, and exhausted to, the interior of the lifeboat.



28. Totally enclosed lifeboat on moorings.

TOTALLY ENCLOSED SURVIVAL CRAFT

These craft (Figure 7.12) are invariably made of glass-reinforced plastic (GRP). They have proved themselves in practice to be a worthwhile advance in the marine field of survival craft, especially with regard to heat-resistance and the exclusion of toxic fumes. These qualities are now statutory for parent vessels engaged on the tanker trades.

The totally enclosed survival craft are self-righting even when fully laden. They contain their own internal air supply, together with a pump for providing an external water mantle to reduce fire hazards.

Tests have shown that a comfortable temperature is maintained inside the craft when outside temperatures have exceeded 1150°C. This desirable quality has been achieved by high standards of fire-resistant resin in the

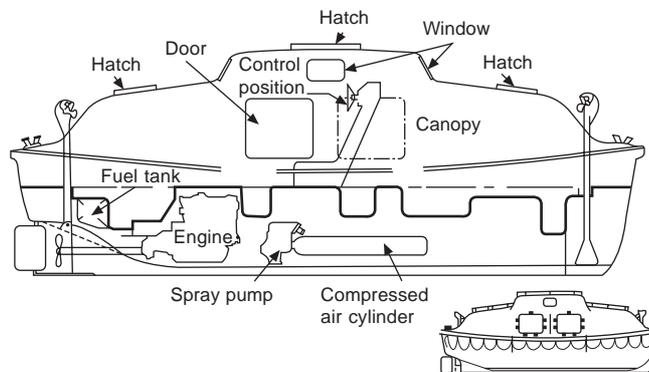


Figure 7.12 Totally enclosed lifeboat.



29. Partially enclosed rescue/lifeboat.

glass fibre construction, in conjunction with the sprayed water mantle from the built-in nozzles about the exterior hull.

These craft are popular not just in oil tankers but also in the offshore oil industry on rigs and platforms. When launching takes place, all hatches should be closed. The release gear may be operated from inside the craft, reducing the risk of accident from floating blocks, which may occur with the conventional davit and open boat systems.

The craft are manufactured with varying carrying capacity and engine size. An example of the performance and capacity of the totally enclosed survival craft, as built by Aberglen–Welin, is as follows:

<i>Capacity</i>	<i>Length (m)</i>	<i>Speed (knots)</i>
21	6.2	6
35	7.3	6
50	8.0	6
66	8.75	6

Speeds can be increased by installing a larger engine but a loss in carrying capacity would result.

The adopted amendments to the SOLAS 1974 have made additional requirements for Passenger Vessels and Cargo ships which became effective from 1 July, 1986 for new tonnage.

Passenger Ships

Those engaged on international voyages, which are not short international voyages, shall carry lifeboats complying with the requirements of: Regulation 42 (partially enclosed boats), Regulation 43 (self righting partially enclosed boats), Regulation 44 (totally enclosed boats) on each side of such aggregate capacity as will accommodate not less than 50 per cent of the total number of persons aboard.

Substitution of lifeboats by life rafts will be permitted provided that there shall never be less than a sufficient number of lifeboats on each side of the vessel to accommodate 37.5 per cent of the total number of persons on board. Life rafts being served by launching apparatus.

In addition there should be life rafts of such aggregate capacity as will accommodate 25 per cent of the total number of persons on board. These life rafts should be served by at least one launching device on each side, which may be those, as stated above.

Cargo Ships (except oil tankers, chemical tankers, and gas carriers)

One or more lifeboats should be carried complying with the requirements of Regulation 44 (totally enclosed boats), of such aggregate capacity on each side of the ship as will accommodate the total number of persons on board.

Cargo ships, if operating under favourable climatic conditions and in suitable areas, may carry boats which comply with Regulation 43 (self righting partially enclosed boats), provided the limits of the trade area are specified in the Cargo Ship Safety Equipment Certificate; and life

raft or life rafts capable of being launched either side and of such aggregate capacity as will accommodate the total number of persons on board. If the life rafts cannot be readily transferred then, on each side, the total capacity available each side shall be sufficient for all persons on board.

Alternative for Cargo Ships

One or more totally enclosed boats capable of being 'Free fall launched, over the stern'. The aggregate capacity of such craft must accommodate all persons on board.

In addition there should be life rafts either side of the ship to accommodate all persons on board, and at least one side of the ship shall be served by a launching device.

Cargo Ships less than 85 metres in length

Cargo ships other than oil tankers, gas carriers and chemical tankers may comply with the regulations by carrying one or more life rafts on either side of such aggregate capacity for all persons on board. Unless these life rafts can be readily transferred for launching either side, additional life rafts shall be provided so that the total capacity available on each side will accommodate 150 per cent of the total number of persons on board.

Oil tankers, chemical tankers, and gas carriers

Those carrying cargoes having a flash point not exceeding 60°C (closed cup test), shall carry fire protected, totally enclosed boats.

In the case of chemical and gas carriers carrying cargoes, which give off toxic vapours, the lifeboats carried must be equipped with a self-contained air support system which complies with the regulations.

Requirements for Totally Enclosed Lifeboats

Every totally enclosed lifeboat shall be provided with a rigid enclosure. The enclosure shall be so arranged that:

1. It protects the occupants against heat and cold.
2. Access into the lifeboat is provided by hatches which can be closed to make the boat watertight.
3. Hatches are positioned so as to allow the launching and recovery operations to be performed without any occupant having to leave the enclosure.
4. Access hatches are capable of being opened and closed from both inside and outside and are equipped with means of holding them securely in the open positions.
5. It must be possible to row the lifeboat.
6. It is capable, when the lifeboat is in the capsized position with the hatches closed and without significant leakage, of supporting the entire mass of the lifeboat, including all equipment, machinery and its full complement of persons.
7. It includes windows or translucent panels on both sides which

admit sufficient daylight to the inside of the lifeboat with the hatches closed to make artificial light unnecessary.

8. Its exterior is of a highly visible colour and its interior of a colour which does not cause discomfort to the occupants.
9. Handrails provide a secure handhold for persons moving about the exterior of the lifeboat and aid embarkation and disembarkation.
10. Persons have access to their seats from an entrance without having to climb over thwarts or other obstructions.
11. The occupants are protected from the effects of dangerous subatmospheric pressures which might be created by the lifeboat's engine.

Capsize and Re-righting

The boats shall all be fitted out with safety seatbelts designed to hold a mass of 100 kg when the boat is in the capsized position. To this end it is essential that the occupants once embarked are securely strapped into the seated areas to ensure the self righting property of the boat becomes a viable proposition. Also all hatches and access doors are battened down and are seen to be in a watertight condition.

The design of the boats should be such that in the capsized situation the boat will attain a position which provides an above water escape. Exhausts and engine ducts will be so designed as to prevent water entering the engine during a capsized period.

Embarkation and Launching of Survival Craft

This information is taken from the 1983 Amendments to the International Convention for the Safety of Life at Sea, 1974.

Launching when Parent Vessel is Making Way

Cargo ships of 20,000 tons gross tonnage and upwards, should have lifeboats capable of being launched, where necessary utilising painters, with the ship making headway at speeds up to 5 knots in calm water.

Free Fall Lifeboats

Lifeboats arranged for free fall launching shall be so constructed that they are capable of rendering protection against harmful accelerations resulting from being launched when loaded with its full complement of persons and equipment from at least the maximum height at which it is designed to be stowed above the water line.

Allowing for the ship to be in its lightest sea-going condition, under unfavourable conditions of trim of up to 20° and with a ship's list of up to 75° either way.

Release Mechanism

Every lifeboat to be launched by a fall or falls shall be fitted with a release mechanism which complies with the following:

- (a) the mechanism shall be so arranged that all hooks release simultaneously;
- (b) the mechanism shall have two release capabilities, namely,
 - (i) A normal release capability which will release the craft when waterborne or when there is no load on the hook.
 - (ii) An on-load release capability which will allow the release of the craft when load is on the hooks. This will be so arranged as to release the boat under any condition from no load with the boat in the water, to when a load of 1.1 times the total mass of the lifeboat (fully loaded) is acting on the hooks. The release mechanism should be adequately protected against accidental or premature use.
- (c) The release control should be clearly marked in a contrasting colour.
- (d) The mechanism shall be designed with a safety factor of 6 based on the ultimate strength of materials used, assuming the mass of the boat is equally distributed between falls.

Painter Release

Every lifeboat shall be fitted with a release device to enable the forward painter to be released when under tension.

Lifeboats with Self-Contained Air Support Systems

Lifeboats with self-contained air support systems shall be so arranged that when the boat is proceeding with all entrances and openings closed, the air inside the lifeboat remains pure and the engine runs normally for a period of not less than 10 minutes. During this period the atmospheric pressure inside the boat shall never fall below the outside atmospheric pressure, nor shall it exceed it by more than 20 mbar. The system shall be provided with visual indicators to indicate the pressure of the air supply at all times.

Fire Protected Lifeboats

A fire protected lifeboat, when waterborne, shall be capable of protecting the number of persons it is permitted to accommodate when subjected to a continuous oil fire that envelops the boat for a period of not less than 8 minutes.

Water Spray Systems

A lifeboat with a water spray system shall comply with the following:

1. Water for the system shall be drawn from the sea by a self priming motor pump. It shall turn 'on' and turn 'off' the flow of water over the exterior of the lifeboat.
2. The seawater intake shall be so arranged as to prevent the intake of flammable liquids from the sea surface.
3. The system shall be arranged for flushing with fresh water and allowing complete drainage.

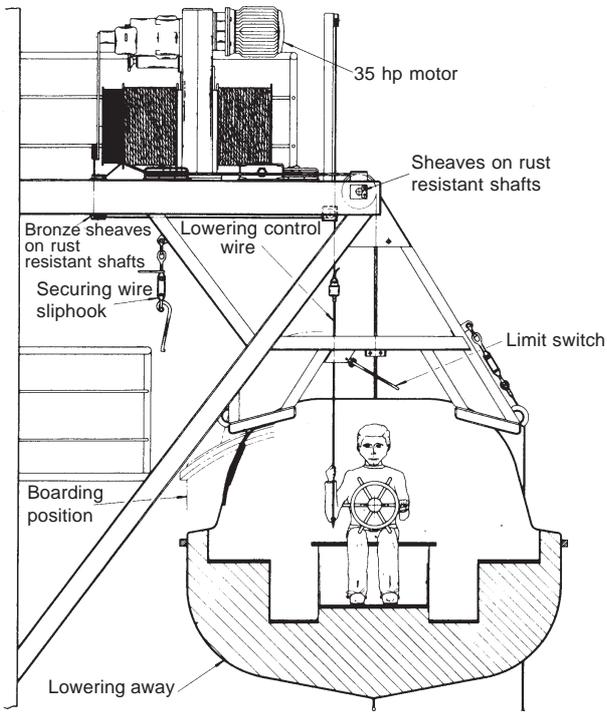


Figure 7.13 Watercraft-Schat launching system.



30. Totally enclosed boat in davit arrangement.

PARTIALLY ENCLOSED BOATS (AS DEFINED BY REGULATION 42)

1. Partially enclosed boats must comply with the general requirements for lifeboats.
2. Every partially enclosed boat shall be provided with effective means of bailing or be automatically self bailing.
3. They shall be provided with permanently attached, rigid covers extending over not less than 20 per cent of the boat's length from the stem, and 20 per cent of the length from the most after part of the boat. The lifeboat will be fitted with a permanent attached foldable canopy which together with the rigid covers completely encloses the occupants of the boat in a weatherproof shelter and protects from exposure.

Arrangement of the Canopy

- (a) The canopy must be provided with adequate rigid sections or battens to permit the erection of the canopy.
 - (b) It must be easy to erect by not more than two persons.
 - (c) It must be insulated to protect the occupants against heat and cold, having not less than two layers of material separated by an air gap or other efficient means of insulation. Means must be provided to prevent the accumulation of water in the air gap.
 - (d) Its exterior should be of a highly visible colour and the interior colour should not cause discomfort to the occupants.
 - (e) It has entrances at both ends and on each side provided with efficient adjustable closing arrangements which can be easily and quickly opened and closed from inside or outside so as to permit ventilation but exclude the seawater, wind and cold. Means shall also be provided for holding the entrances securely in the open and closed positions.
 - (f) With the entrances closed it admits sufficient air for the occupants at all times.
 - (g) It has means for collecting rainwater.
 - (h) The occupants can escape in the event of the lifeboat capsizing.
4. The interior of the lifeboat should be of a highly visible colour.
 5. The radio installation required by the regulations shall be installed in a cabin large enough to accommodate both the equipment and the operator. No separate cabin is required if the construction of the lifeboat provides a sheltered space to the satisfaction of the certifying authority.

Marine students should note that the above is for partially enclosed lifeboats, and not self-righting, partially enclosed boats, which is covered by Regulation 43.

Lifeboat Additional Fittings

(In accordance with the 1983 amendments of the SOLAS 1974 convention)

1. Every lifeboat shall be provided with at least one drain valve fitted

near the lowest point in the hull, which shall be automatically open to drain water from the hull when the lifeboat is not waterborne and shall automatically close to prevent entry of water when the lifeboat is waterborne. Each drain valve shall be provided with a cap or plug to close the valve, which shall be attached to the lifeboat by a lanyard, or chain, or other suitable means. Drain valves shall be readily accessible from inside the lifeboat and their position shall be clearly indicated.

2. All lifeboats shall be provided with a rudder and tiller. When a wheel or other remote steering mechanism is also provided the tiller shall be capable of controlling the rudder in case of failure of the steering mechanism. The rudder shall be permanently attached to the lifeboat. The tiller shall be permanently installed on or linked to the rudder stock; however, if the lifeboat has a remote steering mechanism, the tiller may be removable and securely stowed near the rudder stock. The rudder and the tiller shall be so arranged as not to be damaged by operation of the release mechanism or the propeller.
3. Except in the vicinity of the rudder and propeller, a buoyant lifeline shall be becketed around the outside of the lifeboat (see ropework in lifeboats).
4. Lifeboats which are not self-righting when capsized shall have suitable hand holds on the underside of the hull to enable persons to cling to the lifeboat. The handholds shall be fastened to the lifeboat in such a way that when subjected to impact sufficient to cause them to break away from the lifeboat, they break away without damage to the lifeboat.
5. All lifeboats shall be fitted with sufficient watertight lockers or compartments to provide for the storage of the small items of equipment, water and provisions required by the regulations. Means shall also be provided for the storage of collected rainwater.
6. Every lifeboat shall comply with the GMDSS requirements and have use of VHF radio telephone apparatus. Lifeboat/rescue boats of passenger ships would have a fixed radio installation. Other craft would employ portable two-way 'walkie talkie's'.
7. All lifeboats intended for launching down the side of a ship shall have skates and fenders as necessary to facilitate launching and prevent damage to the lifeboat.
8. A manually controlled lamp visible on a dark night with a clear atmosphere at a distance of at least 2 miles for a period of not less than 12 hours shall be fitted to the top of the cover or enclosure. If the light is a flashing light, it shall initially flash at a rate of not less than 50 flashes per minute over the first 2 hour period of operation of the required 12 hour operation period.
9. A lamp or source of light shall be fitted inside the lifeboat to provide illumination for not less than 12 hours to enable reading of the survival and equipment instructions; however, oil lamps shall not be permitted for this purpose.

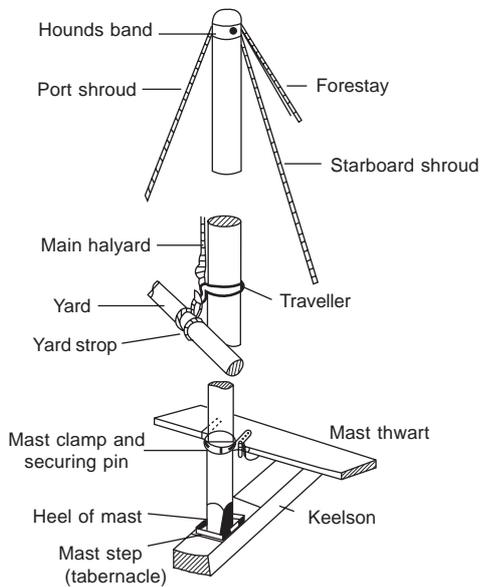


Figure 7.14 Mast and rigging.

10. Unless expressly provided otherwise, every lifeboat shall be provided with effective means of bailing or be automatically self-bailing.
11. Adequate viewing, forward, aft and to both sides of the lifeboat must be provided from the control position to allow safe launching and manoeuvring.
12. Each seating position in the boat should be clearly indicated.

BOAT RIGGING

Mast and Sails

These are carried in boats which are generally not equipped with an engine or other means of mechanical propulsion. The mast is usually wood with metal fittings, including hounds band, traveller, and cleats. Galvanised wire shrouds and forestay (if fitted) are shackled at the masthead, being secured with rope tails or small bottle screws at the gunwale. The heel of the mast is shaped to fit the tabernacle or mast step (see Figure 7.14).

The halyards are made of hemp rove through blocks at the masthead. An alternative arrangement for the main halyard is a single sheave built into the mast itself, one end of the main halyard being spliced on to the traveller. When the mast is down and stowed, the halyards and shrouds etc. are normally twisted about the length of the mast to avoid fouling when the mast is to be stepped. The heel of the mast is stowed facing forward, ready for immediate use and stepping, by walking the mast up from aft to be clamped against the mast thwart.

Many alternative rigs are in use, especially in the private yacht sector of the marine world. Thole pins are often employed in place of cleats for turning up halyards. Stainless steel shackles and bottle screws have replaced rope lashings. Many 'quick link' securing devices have become increasingly popular for attaching sails etc.

Ropework in Lifeboats

Painters

Standard equipment must include two painters, both stowed in the forward part of the boat. One of these shall be permanently secured to the boat and coiled down on top of the bottom boards or in the bow sheets. The second painter should be secured to the release device at or near the bow, ready for immediate use.

Both painters should be of a length equal to not less than twice the distance from the stowage position of the lifeboat to the waterline when the vessel is at her lightest sea-going condition or 15 m, whichever is the greater. The size of painters is normally 20–24 mm manilla or equivalent synthetic cordage.

(Man-made fibres may be used for life saving appliances provided it has been approved by the appropriate authority.) Observation of an approved man-made rope will show a coloured thread/yarn passing through the lay of the rope. The idea is based on the 'Rogues' Yarn'

NB. Following revision of regulations lifeboats must now be fitted with a motor. Mast and sails are therefore no longer carried as standard equipment.

Mast and sail detail has been retained within the text to provide general seamanship information.

method of identifying the various dockyards from which ropes originally came, and so prevent theft between ships.

Buoyant (becketed) Lifeline

Each lifeboat will be provided with a buoyant lifeline becketed around the outside of the boat, except in the vicinity of the rudder and the propeller. These are often manufactured in a synthetic material having a wood hand grip rove in the bight. If natural cordage is used it is normally of 16 mm size, beckets being spaced approximately 60 cm apart. Its purpose is to provide hand holds for survivors in the water. With this idea in mind the height of beckets should be just clear of the water surface when the boat is fully loaded.

Keel Grab Lines (if fitted)

These are fitted to assist the righting of a capsized, conventional boat. They are secured inside the boat, on either side, passing from gunwale to gunwale under the keel. They will normally be secured having 'figure 8' knots on either side of the boat to provide hand holds, together with a sheepshank directly under the keel. This sheep shank can be released when the boat is in a capsized condition and the increased bight of the line can be used in conjunction with an oar to form a spanish windlass and so lever the boat over into a correct upright position. Keel grab lines are usually of 20 mm manilla or suitably approved cordage.

Lifelines

Not less than two lifelines are required for partially enclosed boats. These must be secured to the span between the davit heads and should be of sufficient length to reach the water with the ship in its lightest condition under unfavourable conditions of trim with the ship listed not more than 20° either way. They should be of an approved cordage 20 mm size, and seized to the span not less than 30.5 cm away from the davit heads so as not to foul the fall wires.

Lifeboat Falls

Falls shall be constructed in corrosion resistant steel wire rope having rotation-resistant properties.

An example in use is 'Kilindo' 18 × 7. It is a multi-strand wire which involves laying up round strands in the opposite direction to the previous layer of strands. Although termed a non-rotating rope, this is not strictly accurate because the separate layers of strands do twist, but each layer of strands turns in an opposing direction giving a balance effect when hoisting/lowering.

Lifeboat falls shall be long enough for the survival craft to reach the water with the ship in its lightest seagoing condition, under unfavourable conditions of trim and with the ship listed not less than 20° either way.

Maintenance

Falls used in launching shall be turned 'end for end' at intervals of not more than 30 months and be renewed when necessary due to deterioration, or at intervals of not more than 5 years, whichever ever is the earlier.

Rate of Descent

The speed at which the survival craft or rescue boat is lowered into the water shall not be less than that obtained from the formula:

$$S = 0.4 + (0.02 \times H)$$

where S = speed of lowering in metres per second; and H = height in metres from davit head to the waterline at the lightest seagoing condition.

The maximum lowering speed is established by the authority taking note of the design of the craft, the protection of its occupants from excessive forces and the strength of the launching appliance (taking into account inertia forces during an emergency stop). Means must be included in the system to ensure that the speed is not exceeded.

Bowsing in Tackles

Small rope tackles, usually double luff, these are secured between the foot of the davit aboard the parent vessel and the loose linkage under the floating block. Their purpose is to relieve the weight from the tricing pendants and allow the conventional boat to be eased out away from the ship's side during the lowering operation to the waterline (see Figure 7.15).

The tackles are rove to disadvantage, with the downhaul leading into the boat. When they are secured, it is normal to use a round turn with two half hitches on the bight. This will enable the two men manning the tackles at each end to slack away together on the round turn, and also check the motion of the boat should it be going off in an uneven manner.

Each block is fitted with a hook/swivel fitment to allow securing in an easy manner with minimum loss of time.

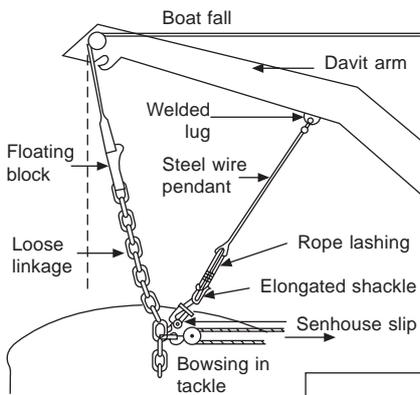


Figure 7.15 Use of tricing pendant.

Tricing Pendant

This is a short length of steel wire rope, having a senhouse slip and a rope lashing at one end, with a shackle secured to the underside of the davit arm at the other end (Figure 7.15). The purpose of the tricing pendants is to 'trice the boat into the ship's side', to allow persons to board the boat safely. This precaution is particularly important if the parent vessel has an adverse list, which would cause the boat to be slung in the vertical away from the ship's side.

The pendants are secured between the linkage directly under the floating block to the underside of the davit. The senhouse slip is held secure by a wooden pin, which will not rust or jam and can easily be broken to release. The reason the rope lashing is incorporated into the

make-up of the pendant is that it can be cut in an emergency. Tricing pendants should be released once the bowsing in tackles are secured. Survivors should then board while the weight of the boat is bowsed in. The tackles can then be paid out and released before lowering.

Gripes

These are constructed of steel wire rope that has a rope lashing and a bottle screw with senhouse slip incorporated in its length. The purpose of the gripes is to hold the boat firmly against its stowage chocks and keep it in a secured stowed position in the davits.

There are several methods of gripping the boats against the davit chocks, one system being shown in Figure 7.16. It will be seen that the gripe wire is secured to the trigger lever, passing over the gunwales of the boat and then being secured via lead sheaves to the inside foot of the davit.

The gripes are cleared by compressing the two parts of the senhouse slip and clearing away the securing link. Once the slip and bottle screw are released, the gripe can be passed back over the boat and the end cleared. However, some gripes are interconnected to the trigger system, and the men in the boat clearing the gripes over the gunwales should in fact check and report that the triggers have fallen and the davits are clear to lower away. The cox'n in charge of the launching operation should also check that the securing end of the gripe does not fall under the lowering davit arm, causing buckling, or fouling the lowering operation.

In re-securing the gripes the bottle screw arrangement will need to be opened up, in order to pass the senhouse slips. Once this is done, the gripes can be re-tensioned by use of the screw. A rope lashing is incorporated for the same purpose as with the tricing pendant, so that it may be cut in an emergency.

LAUNCHING PROCEDURE

Gravity Davits

These davits (Figure 7.16) operate on the principle of the boat's own weight doing the work to bring about the launch. The construction of the davits includes a safety device, usually a trigger arrangement attached to the gripes; and when launching, care should be taken to check that these triggers are cleared before proceeding.

Gravity davits must be fitted with steel wire rope falls and operated by a controlled winch. The rate of descent of the boat is separately controlled by a centrifugal brake. A main ratchet type brake is also incorporated in the more modern designs, and it can hold the boat at any stage of lowering. This may be operated, in some cases, from inside the craft itself, so that the launching cycle can be carried out remotely, thus saving time once waterborne for taking on personnel.

The majority of gravity davits are fitted with tricing pendants, and the boat must be equipped with means of bowsing in against the ship's side to permit the removal of the pendants before embarking personnel.

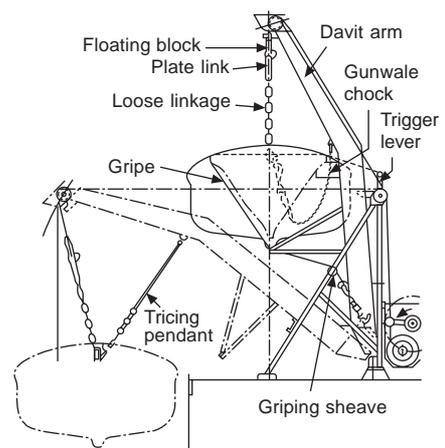


Figure 7.16 Pivot gravity davit.

The davits will successfully launch the boat against a 25° adverse list in the following way:

1. Two men should be ordered into the boat, to ship the plug and check that the painter is rigged in a correct manner. (Painter is passed inside the fall and outside everything else, and secured well forward.) Once all work inside the boat is complete, these two men should be seen to sit down in the boat and hold on to the lifelines.
2. The cox'n should check that the harbour pins are out.
3. The gripes should be slipped and any triggers checked to see that they are clear, the gripes being passed down to deck level clear of the boat.
4. A winchman must be ordered to stand by to lower the boat down to the embarkation deck.
5. Check that the overside is clear, then lower away by lifting the brake handle. The boat should descend from the davits until the tricing pendants take the boat's weight and draw the boat into the ship's side.
6. The bowsing in tackles should be rigged in such a manner that the downhaul is secured in the boat with a round turn and two half hitches, on the bight about the linkage on the end of the falls.
7. Have the two men in the boat slip the tricing pendants once both ends of the boat are securely bowsed in.
8. The remainder of passengers and boats crew should now be embarked, and seated as low as possible in the boat.
9. Ease out on the bowsing in tackles and allow the boat to come away from the ship's side, then let go the tackles from inside the boat and throw them clear, back towards the parent vessel.
10. Order the winchman to lower the boat with a run. Ship tiller.
11. Unless release gear is fitted to the boat, it is more practical to lower the boat into a trough of a wave. As the crest of the wave brings the boat higher, this will allow the falls to become slack, which will in turn allow easy slipping from the lifting hooks. Once the falls are clear, the boat falls away from the ship's side as the wave drops away.

Should quick release gear be fitted to the boat being launched, then it would be more practical to slip the release mechanism as the boat takes the crest of a wave. As the wave drops away into a trough, so it takes the boat away from the ship's side with it.

The time of the boat becoming waterborne is the most critical, and many serious accidents have occurred in the past. The floating heavy blocks of the falls are a major cause of the accidents, as they are in the direct vicinity of the boat in the water and they oscillate wildly at head height. A prudent cox'n will endeavour to clear the area as soon as possible. An alternative means of reducing this danger is to secure light lines to the floating blocks of the falls and manning them by additional personnel on deck. Once the boat has slipped the falls, these blocks can

be pulled up clear, back aboard the parent vessel out of harms way. Personnel in the boat could also wear prefabricated crash helmets as an additional safeguard.

Launching Stations

Launching stations shall be in such positions as to ensure the safe launch of survival craft, having particular regard to clearance from the propeller and steeply overhanging portions of the hull. As far as possible survival craft, except free-fall craft, should be arranged to allow launching down the straight side of the ship. If positioned forward, they shall be located abaft the collision bulkhead and in a sheltered position.

The stowage arrangement shall be such that it will not interfere with the launching operation of other survival craft or rescue boat at any other station. Craft should be stowed as close to the accommodation as possible, and their muster and embarkation areas should be adequately illuminated supplied by an emergency source of electrical power.

Each launching station, or every two adjacent launching stations, should have an embarkation ladder which complies with the regulations. This ladder should be constructed in a single length and reach from the deck to the waterline in the lightest seagoing condition under unfavourable conditions of trim and with an adverse list of 15° either side. These ladders may be replaced by approved devices which provide access to survival craft when waterborne, however, at least one embarkation ladder would still be a requirement, on either side.

Survival craft should be maintained in a continuous state of readiness, so that two crew members could prepare for embarkation and launching in less than 5 minutes (fully equipped). They should be attached to their respective launching devices and positioned so that in the embarkation situation they are not less than 2 m above the waterline when the ship is in the fully loaded condition, and listed up to 20° either way. Lifeboats for lowering down the ship's side should be positioned as far forward of the propeller as is practical.

On Cargo Ships

Of 80 m in length and upwards but less than 120 m in length each lifeboat shall be stowed so that the after end of the lifeboat is not less than the length of the lifeboat forward of the propeller.

On Cargo Ships 120 m or over and Passenger Ships of 80 m and over

Each lifeboat shall be stowed so that the after end of the boat is not less than 1.5 times the length of the lifeboat forward of the propeller.

Launching Appliances

Information regarding Launching and Embarkation Appliances is covered by Regulation 48, in section VI, Chapter III of the International Convention for the Safety of Life at Sea.

Salient points have been extracted below.

1. Every launching appliance together with its lowering and recovery gear should be so arranged that the fully equipped survival craft or rescue boat can be safely lowered against a trim of 10° and a list of 20° either way (a) when boarded by its full complement, from the stowed position; and (b) without persons on board.
2. A launching appliance shall not depend on any means other than gravity or stored power which is independent of the ship's power supply, to launch the survival craft in the fully loaded condition.
3. Launching must be possible by one person from a position on the ship's deck and that person should be capable of keeping the survival craft or rescue boat visible throughout the launching process.
4. Winch brakes of launching appliances should be of sufficient strength to withstand the static test and the dynamic test.
5. Structural members, blocks, falls, links, pad eyes, and all fastenings shall be designed with not less than a minimum factor of safety on the basis of the maximum working load assigned and the ultimate strength of the material used for construction. A minimum factor of safety of 4.5 shall be applied to all davit and winch structural members, and a minimum factor of safety of 6 shall be applied to all falls, suspension chains, links and blocks.
6. The lifeboat launching appliance should be capable of recovery of the lifeboat with its crew. Operating speed not less than 0.3 m/s.
7. Every launching appliance shall be fitted with brakes capable of stopping the descent of the survival craft or rescue boat, holding it securely with its full complement of persons and equipment. Brake pads shall, where necessary, be protected from oil and water.
8. An efficient hand gear shall be provided for the recovery of each survival craft or rescue boat.
9. Where davit arms are recovered by power, safety devices shall be fitted which will automatically cut off the power before the davit arm reaches the stops in order to prevent overstress on the falls, unless the winch is designed to prevent such overstressing.
10. Falls shall be of rotation-resistant steel wire rope. They should wind off the drums at the same rate when lowering and wind on to the drums evenly at the same rate when hoisting (multiple drum winch).

Survival Craft, Launching and Recovery Arrangements

Launching appliances complying with the regulations shall be provided for all survival craft except:

1. Survival craft that are boarded from a position on deck that is less than 4.5 m above the waterline in the lightest seagoing condition and that either:
 - (a) have a mass not more than 185 kg; or
 - (b) are stowed for launching directly from the stowed position under unfavourable conditions of trim of up to 10° and with the ship listed not less than 20° either way.

2. Survival craft having a mass of not more than 185 kg and which are carried in excess of the survival craft for 200 per cent of the total number of persons on board the ship.

Each appliance provided must be capable of the launching and recovery of the craft. Throughout any launch or recovery operation the operator of the appliance is able to observe the survival craft.

During the preparation and launching operation, the survival craft, the launching appliance and the water area to which the craft is being launched shall be adequately illuminated by lighting supplied from the emergency source of electrical power, required by the regulations. Preparation and handling of survival craft at one launch station shall not interfere with the handling of any other survival craft or rescue boat.

The release mechanism used for similar survival craft shall only be of one type carried aboard the ship.

Passenger Ships

All survival craft provided for abandonment in passenger ships by the total number of persons on board shall be capable of being launched with their full complement of persons and equipment within a period of 30 minutes from the time the abandon ship signal is given.

Cargo Ships

With the exception of survival craft mentioned in 1(a), all survival craft required to provide for abandonment by the total number of persons on board shall be capable of being launched with their full complement of persons and equipment within a period of 10 minutes from the time the abandon ship signal is given.

Lifeboats of the partially enclosed type, if carried, shall be provided with a davit head span, fitted with not less than two lifelines of sufficient length to reach the water with the ship in its lightest seagoing condition, under unfavourable conditions of trim and with the ship listed not less than 20° either way.

Lifeboat launching Appliances for Oil Tankers and Gas Carriers, with a final angle of heel greater than 20°

These shall be capable of operating at the final angle of heel on the lower side of the ship.

Launching Stations

Embarkation Ladders

Hand holds shall be required to ensure a safe passage from the deck on to the head of embarkation ladders and vice-versa.

Construction of the Ladder

The Steps

- (a) These shall be made of hardwood, free of knots or other irregularities,

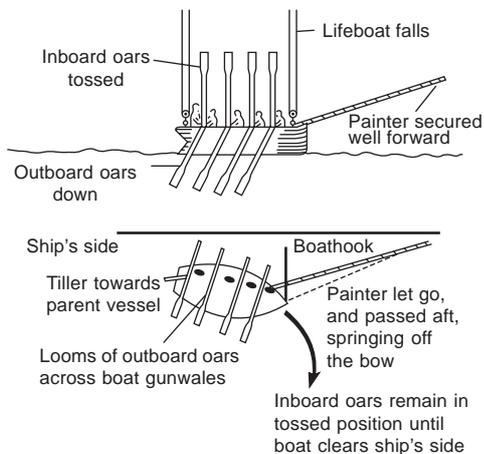


Figure 7.17 Taking boat away from ship's side of parent vessel stopped.

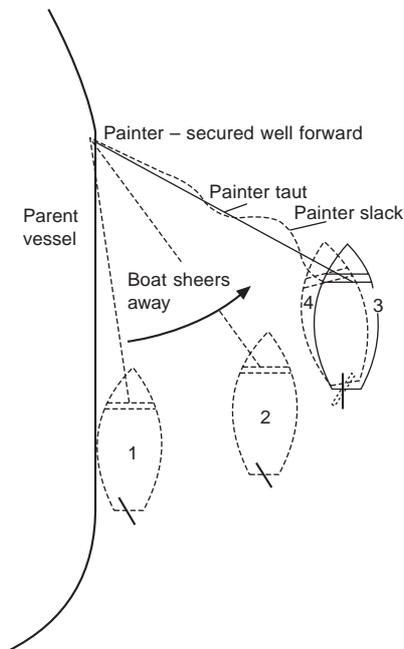


Figure 7.18 Taking boat away from ship's side when parent vessel is making way.

1. Boat launched and secured by painter alone, tiller towards the parent vessel.
2. Boat sheers away from ship's side by continued effect of the tiller being towards the ship.
3. A position of maximum sheer is reached, tiller is eased to amidships, maintaining a forward motion of the boat and keeping the painter taut.
4. Tiller is briefly pushed away from the parent vessel, allowing the painter to go slack as the bow of the boat turns in towards the parent vessel. At this point, slip the painter.

smoothly machined and free from sharp edges and splinters, or of a suitable material of equivalent properties.

- (b) They will be provided with an efficient non-slip surface either by longitudinal grooving or by the application of an approved non-slip coating.
- (c) They shall be not less than 480 mm long, 115 mm wide and 25 mm in depth, excluding the non-slip surface or coating.
- (d) They shall be equally spaced not less than 300 mm or more than 380 mm apart and secured in such a manner that they will remain horizontal.

The Side Ropes

The side ropes shall consist of two uncovered manilla ropes not less than 65 mm in circumference on each side. Each rope should be continuous with no joints below the top step. Other materials may be used provided the dimensions breaking strain, weathering, stretching and gripping properties are at least equivalent to those of manilla rope. All rope ends shall be secured against unravelling.

Free Fall Launching

Free fall launching is defined as that method of launching a survival craft whereby the craft with its complement of persons and equipment on board is released and allowed to fall into the sea without any restraining apparatus.

Every free fall launching system must comply with paragraph 1, of Regulation 48, regarding the launching and embarkation appliances. In addition it should also comply with the following:

- (a) The launching appliance shall be so arranged that excessive forces are not experienced by the occupants of the survival craft during launching.
- (b) The launching appliance shall be a rigid structure with a ramp angle and length to ensure that the survival craft effectively clears the ship.
- (c) The launching appliance shall be efficiently protected against corrosion and be so constructed as to prevent incendive friction or impact sparking during the launching of survival craft.

TAKING BOAT AWAY FROM SHIP'S SIDE

This is always a dangerous operation, for conditions at sea level may not always be apparent to a person standing up high above the water, as on the bridge of an ocean-going vessel. It is always preferable for the parent vessel to provide a lee, if possible, for the launching of the boat, so giving a limited amount of shelter from the wind. In fact, the parent vessel may be either stopped in the water and making no way or under way at reduced speed. The launching of a boat with the parent vessel at any speed over 3 to 4 knots must be considered extremely hazardous, and should not be attempted under normal circumstances.

Parent Vessel Stopped

Boat under Oars

This is the more acceptable condition for launching a boat, but care should be taken with the effects of swell and wind when the falls have been released. Figure 7.17 indicates the use of ‘bearing off’ with the looms of the outboard oars. Although this is a practical method, use of ‘springing off’ by pulling the painter down the inboard side of the boat can prove just as effective. Springing off may be the only alternative should the boat be in the water under the curved lines of the stern of the parent vessel. There could be the distinct possibility of breaking the looms of the oars by trying to bear away with them in or around this stern area.

The bowman should endeavour to combine his action of letting go the painter and springing off, by pulling it down the inboard side and bearing off by use of the boathook. The bowman’s efforts, together with the combined weight of the outboard oarsmen, should turn the bow of the boat far enough away from the ship’s side to enable the inboard oarsmen to down their oars and give way.

After the outboard oarsmen have borne away on the looms of their oars, a prudent cox’n will order them to hold water. With additional use of the rudder he will try to bring the fore and aft line of the boat at a broad angle to the ship’s side, so gaining sea room with any forward motion of the boat.

Parent Vessel Making Way

Boat under Power

Once the boat falls have been released and the boat is held on the painter, push the tiller towards the ship’s side. This action effectively gives the boat a sheer. Keep the painter taut until the boat reaches a point of maximum sheer, then briefly alter the position of the tiller so that the bow cants inwards towards the parent vessel. The results of this action will be for the painter to become temporarily slack, which will permit its easy slipping. Push tiller towards the ship’s side and gain sea room (see Figure 7.18).

BOAT RECOVERY IN HEAVY WEATHER

If a boat is lowered at sea for a specific job, under normal circumstances that boat must be recovered before the voyage can proceed. This operation may become extremely hazardous with a heavy swell running or with a rough sea. To this end a recommended method of recovery is given below.

Preparation

Secure a wire pendant to an accessible point on the davit arms (Figure 7.19, section 1). Extreme care must be taken to ensure that the strop and

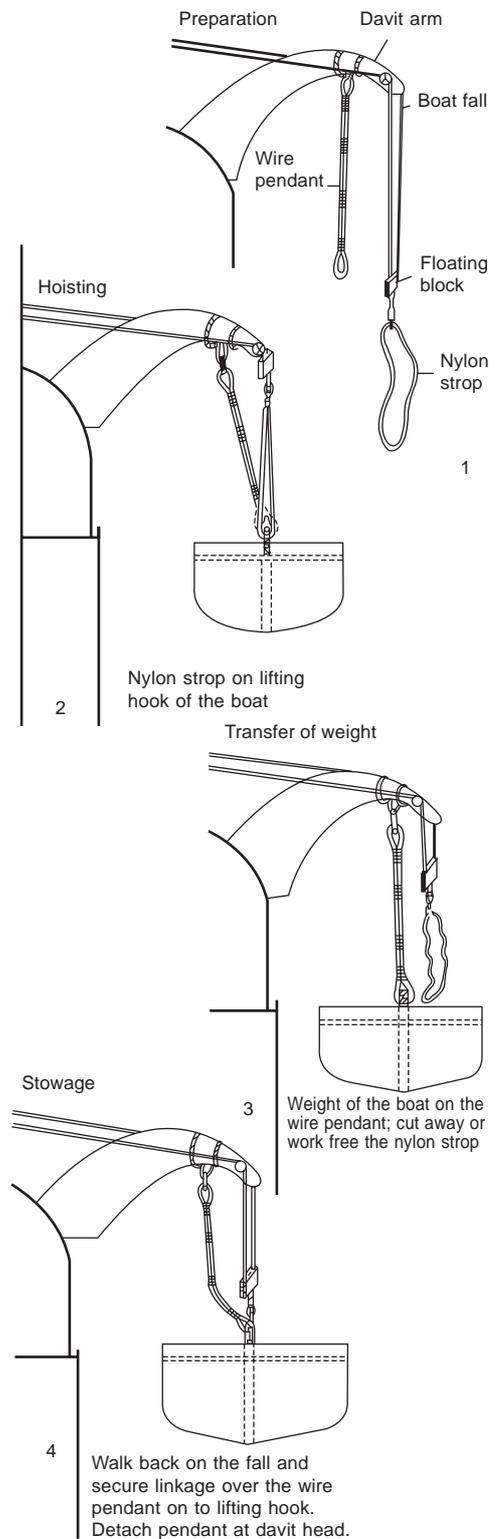


Figure 7.19 Boat recovery in heavy weather.

the wire pendant, together with any shackles used, are of sufficient strength to accept the weight of the fully laden boat. The boat falls should be retrieved at deck level and nylon rope strops shackled to the linkage from the floating blocks, since rope strops are easier to handle than chain in the confines of the oscillating conditions of the boat in the water. The wire pendant and the boat falls, together with the nylon strops, should be set up above the waterline as in Figure 7.19, section 1. Ensure that the strop is also of adequate strength to support the full weight of the laden boat.

Hoisting

If the operation is taking place on a Class 1 passenger vessel, then the sequence of actions are made easier by the use of the rams horn lifting hook, a standard fitment in the emergency boats of passenger vessels. However, where a single lifting hook is to be used, as with Class 7 vessels, then the method of recovery can be achieved in the following way: fit both nylon strops over the lifting hooks, fore and aft in the boat and hoist the boat clear of the water until the floating blocks are 'block on block' with the davit head (Figure 7.19, section 2).

It is at this stage that the wire pendant is secured to each of the lifting hooks, on top of the nylon strops. If a rams horn hook was being used, then the opposing half of the hook would accommodate the pendant. The idea at this stage is to transfer the weight of the boat from the falls to the wire pendants, so that the boat falls may be correctly secured.

Transfer of Weight

This can only be achieved as shown in Figure 7.19, section 3 if the wire pendant is long enough to reach from the davit head to the lifting hook in the boat when the floating blocks are hard up at the davit head. By walking back on the boat fall, the weight comes on to the pendant and the strop becomes slack. This is the time either to cut away the strop at the hook or unshackle the other end from the linkage of the floating block.

Stowage

Continue to walk back on the falls to enable the open links to be slipped over the wire pendants and the lifting hooks, hoist away and take the weight on the falls. Detach the pendants from the davits and restow the craft.

BEACHING A LIFEBOAT

This is always a dangerous operation and should be carried out during the hours of daylight only. If approaching the shoreline at night it is recommended to wait until daybreak.

All preparations should be made well outside the line of surf and a plan of approach should be well thought out in advance.

If under Sail

1. Let fly sheets, down helm, and bring the boat head into the wind.
2. Stream the sea anchor over the bow with the boat's position stern to the beach.
3. Lower the sails and strike the mast.
4. Unship the rudder and tiller and rig a steering oar in a grommet.
5. Man the pulling oars.
6. Allow the boat to drift easily astern into the line of surf by periodically tripping the sea anchor and using the oars.
7. Beach stern first, keeping the bow head on to the direction of surf.

If under Power

Depending on the sea conditions and the design of boat, beaching under power can be made either head on, or stern on, to the beach. Mariners are naturally adverse to obstructing propeller, especially so, if the boat is to be used again at a later time. A method of running before the surf and beaching bow first is a viable alternative to the 'stern first approach' provided the boat's speed can be employed to equal the rate of the following sea. This approach will, by its very nature, be a fast exercise, even with engine power at slow speed, the character of the surf dictating the rate of approach. Also if there are obstructions on the approach there is far less time to take avoiding action, even if sighted.

The method should in any event never be attempted with boats with a transom stern. Coxswains if approaching bow first will require considerable experience and use decisive judgement, once inside the line of surf.

Beaching under power, stern first, is slower and must generally be considered safer. Use of the sea anchor over the bow with combined use of the boat's engines should provide the required force to keep the bow end on to the direction of surf. Pulling oars should be kept ready in the event of engine failure and for use prior to striking the beach itself. An obvious danger of the propeller turning on the final approach must be considered. This is especially so if it is the intention to put men over the side, once the boat enters shallows. The propeller should always be stopped before people are despatched to drag the boat up to the beach.

Ideal Conditions

The ideal conditions for beaching would be a gentle sloping beach, sandy and free from rocky obstructions, with little or no surf and calm weather conditions. As all these factors are unlikely to occur, the coxwain should minimise the risk of injury by keeping all non-essential personnel low down in the boat, seated on the bottom boards and away from the forward and after sections.

Once the boat comes stern on to the beach all persons should disembark over the stern, never over the bow. A bowman should keep the tension on the sea anchor hawser, to prevent the boat from broaching too.

As soon as practical after people are ashore the sea anchor should be tripped and the boat together with its equipment should be salvaged.

BOAT HANDLING AND SAFE PROCEDURES

Responsibilities of the Coxswain

1. To check that all crew members and passengers are wearing lifejackets, and that these are secured in a correct manner.
2. To ensure that all crew members and other personnel are correctly attired, preferably in soft soled shoes, warm clothing and oilskins or immersion suits.
3. To inspect the boat before embarking personnel and ensure that all equipment and the boat's condition are in good order.
4. To maintain authority and make all orders in a clear manner to ensure the safe handling of the boat.
5. To check overside that the launch area is clear and free of obstructions.
6. To carry out an orderly safe launch, take the boat away from the ship's side, and carry out any operations in a correct manner.
7. Throughout all boat operations the cox'n's responsibility is for the safety of his own crew; any decisions taken should bear this in mind, at all times.

Methods of Attracting Attention

1. Use of the orange smoke canister. Thrown overboard, downwind, this is most effective for attracting the attention of a rescue aircraft.
2. Use of the red hand flare. Hold at arm's length, overside, to reduce the risk of fire in the survival craft. Extreme care should be taken in its use with the rubber fabric of the buoyancy chambers of a life raft. It is most effective for attracting rescue aircraft.
3. Use of the rocket parachute flare. Hand held, this activates at about 300 m and will burn for 40 seconds, producing 30,000 candela. Most effective use is to attract surface rescue vessels.
4. Emergency use of: EPIRB, SART or portable VHF radio telephone.
5. Raising and lowering the arms is an international distress signal, but only effective at close range and best used in conjunction with another signal.
6. Transmission of SOS by any available means, e.g. by use of the torch or by radio.
7. Burning rags, showing flames from a bucket or other improvised holder. If burning a small quantity of oil, then black smoke becomes the focal point, easily seen by a rescue aircraft.
8. Heliograph, to direct the rays of the sun. This is effective for aircraft or surface rescue operations, but the range is limited and it is effective only on sunny days.
9. A square flag, having above or below it a ball or anything resembling a ball. These two distinctive shapes, seen at a distance, are an international signal of distress.
10. A gun or other explosive signal, or the continuous sounding of the whistle.

Dangers in Open Boat

These come mainly from exposure and capsizing, with subsequent drowning or injury to the occupants. Experienced handling of the boat with correct use of its equipment can limit the possibility of disaster. Prudent use of the 'sea anchor' and the oil bag will go a long way to increase the chances of survival.

MARKINGS ON SAILS

Letters on sails indicate the first and last letters of the name of the 'mother ship' to which the boat belongs, e.g. 'LN' for *Lancastrian*. Any number with the letters would indicate the side it was stowed on and which boat it was, e.g. '2' for Port Side – 1st boat; for all boats on the starboard side are given odd numbers, and all boats on the port side even numbers (see Figure 7.20).

The parts of a sail are also illustrated in Figure 7.20.

SAIL THEORY

Tacking

This operation is carried out when a boat under sail wishes to change her course from the port tack to the starboard tack, or vice-versa (Figure 7.21). It is sometimes referred to as going about, and is not always a practical method of altering course, especially if the wind is either too strong or too light. The operation entails passing the bow through the wind, so bringing the wind direction to the opposite side of the boat, thus changing tack.

In order to complete the operation successfully it will be necessary for the boat to have enough way on her to carry the bow through the wind. To this end it may be required to 'up helm' and allow the boat to 'pay off' from the wind and increase her speed before attempting to 'go about'.

Once the boat comes head to wind, the experienced sailor will adjust the weight distribution in the boat by transferring the passenger(s) to the new weather side. It may also be prudent to back the jib to assist the bow through the wind.

Wearing

This operation is carried out when it is considered dangerous to tack or conditions make it impractical to do so (Figure 7.22). The result of wearing is to alter the course of the boat, by passing the stern through the wind.

The main feature of the operation is that when the wind is on the quarter, the mainsail is lowered to avoid 'gybing'. As the stern passes through the wind and the wind direction effectively acts on the opposing quarter, the mainsail is reset.

Gybing

Should this method of changing the course of the boat be employed, then extreme care must be taken to control the operation. The main

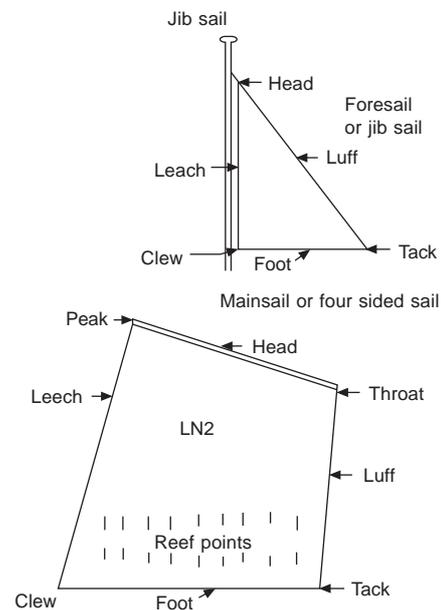


Figure 7.20 Sails.

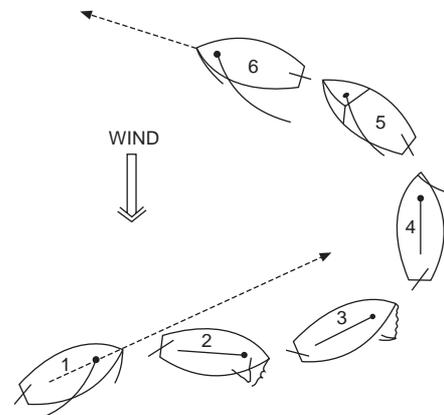


Figure 7.21 Tacking.

1. Boat on port tack.
2. Up helm, to increase the way on the boat.
3. Down helm, let fly jib sheet, take in on main sheet, hauling mainsail aft.
4. Boat head to wind. Bow passes through wind, aided by backing the jib sail.
5. Bow passes through wind; ease out on mainsheets to fill mainsail.
6. Trim sheets of jib and main sails, set course on starboard tack.

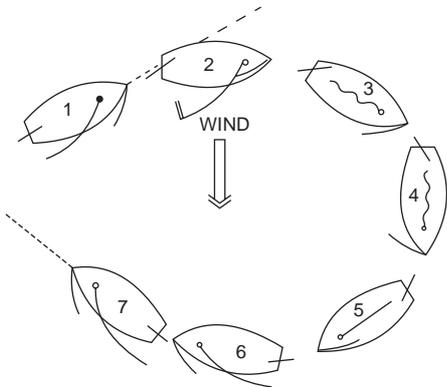


Figure 7.22 Wearing.

1. Boat on port tack.
2. Up helm, ease out main sheets.
3. Wind on port quarter, mainsail lowered.
4. Boat continues to make headway on jib sail. Stern passes through wind.
5. Wind on starboard quarter, reset mainsail, trim jib sail.
6. Ease up helm, and trim jib and main sails.
7. Set course on starboard tack.

dangers of an uncontrolled gybe are that a man may be knocked overboard by the lower boom swinging across the boat or that the boom may react so dramatically when caught by the wind that the boat is dismasted or capsized, especially if great care is not taken in handling the main sheet.

If the gybe is carried out in a controlled manner, the effect of the boom crossing from one side to the other may be cushioned by reducing the slack in the sheets as the stern passes through the wind. In addition, the speed of the manoeuvre could be reduced, providing an easier resultant motion.

Running Before the Wind

This is a term used to describe the boat when she is sailing with the wind from dead astern (Figure 7.23). She is said to be running before the wind with her sails out on the same side, the sheets being at right-angles to the fore and aft line.

Goosewinging

This is a similar condition to running before the wind, except that the sails are out on opposite sides, producing a greater sail area exposed to the wind (Figure 7.24). The sheets are again set at right-angles to the fore and aft line, a style that appears popular with yachtsmen.

Reefing

This is a procedure for reducing the sail area should the wind increase in strength to such a point as to make sailing under full canvas a dangerous proposition. To sail under strong wind conditions with full canvas is to invite capsizing, with all its serious consequences.

The mariner should bear in mind that if the wind increases to such strength that it becomes extremely hazardous to continue to sail, then the alternative would be to heave to and ride to the sea anchor. Reefing would be carried out in order to keep sailing in a safe manner, e.g. when making a landfall.

Reefing procedure is as follows:

1. Down helm, bring the boat head to wind and let fly the sheets.
2. Stream the sea anchor, steadying the boat's head.
3. Lower the mainsail, and detach the yard stop from the traveller.
4. Lay the yard on the side benches, and clear the foot of the sail.
5. Secure the luff earring to the tack cringle.
6. Secure the leach earring to the clew cringle.
7. Gather up the foot of the sail and tie the reef points from forward to aft.
8. Rehook the yard stop on to the traveller and reset the sail.
9. Trip the sea anchor and retrieve it, then resume the course.

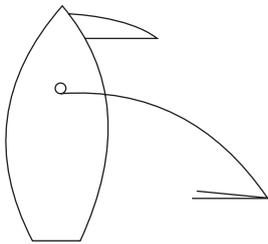


Figure 7.23 Running before the wind. The speed of the boat is reduced to that attainable with the wind on the quarter. An accidental gybe is possible, should a wind change occur. The sea anchor streamed over the stern, providing the drogue effect, will limit the risk of broaching to.

In boats fitted with booms the reef points should be passed around the foot of the sail, never around the boom.

SAIL TERMINOLOGY

Beating

This is a general term used to describe the passage of a boat which is working her way to windward by a series of alternate tacks.

Broad Reach

A boat is said to be sailing on a broad reach if the wind is just abaft its beam.

Close Hauled

A boat is close hauled when she is sailing as close to the wind as she can possibly get. Some modern sailing vessels may point as close as three points to the wind, but it is convention that a boat can effectively sail no closer to the wind than six points of the compass.

Close Reach

A boat is said to be on a close reach if the wind is just forward of her beam.

Luff

An expression to describe the boat's head moving closer to the direction of the wind, e.g. 'to luff up' to wind.

Pay Off

An expression used to describe the boat's head moving further from the direction of the wind.

Stays

The condition often referred to as 'in irons' occurs when a boat is changing from one tack to another, or when the wind drops and allows a vessel to come head to wind, where she will neither pay off to port or starboard tack. If the head fails to pay off on to the opposite tack during an attempt to tack, and falls back to its original position, then the boat is said to have 'missed stays'.

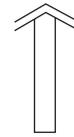
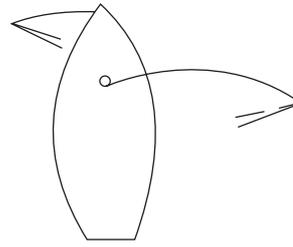


Figure 7.24 Goosewinging.

SURVIVAL CRAFT AND PRACTICE



SURVIVAL SYSTEMS INTERNATIONAL

This is an alternative to the lifeboat or life raft for use by oil rigs and production platforms. It provides protection from fire, toxic fumes, explosion, swamping, capsizing and exposure, in much the same way as the totally enclosed lifeboat.

It is manufactured in a fire retardant fibreglass reinforced plastic, having an external international orange coloured surface. It is now built in three sizes, to accommodate 21, 36, and 50 persons and each capsule is fitted with all standard equipment for basic survival needs. The structure incorporates a ventilation system, a fire sprinkler system for the exterior, seat belts and a 40 H.P. Westbeck, water cooled diesel engine.

Launching is achieved by a winch and single cable system from platform level. An independent release from the fall being possible by operation of an offload release gear.

The launching and recovery of the capsule is operated by a 25 horsepower electric motor. Speed of lowering is approximately 135 ft/min, hoist speed being at about 60 ft/min.

The wire cable is 2.22 cm in diameter, galvanized steel wire rope. Its construction being 3×46 torque balanced, non-rotating, having a breaking strength of 84,000 lb. A similar design has been adopted for a larger model to hold 50/54 people, the wire cable size being increased to 2.54 cm in diameter to support the extra weight.

THE INFLATABLE LIFE RAFT

Construction

There are several manufacturers of life rafts who supply inflatables to the merchant and military services throughout the world, e.g. Beaufort, R.F.D., Dunlop and Viking. The size of rafts will vary with customer requirements but their capacity will be not less than six persons. The largest rafts currently in use are of a 120 man size employed in the marine evacuation systems.

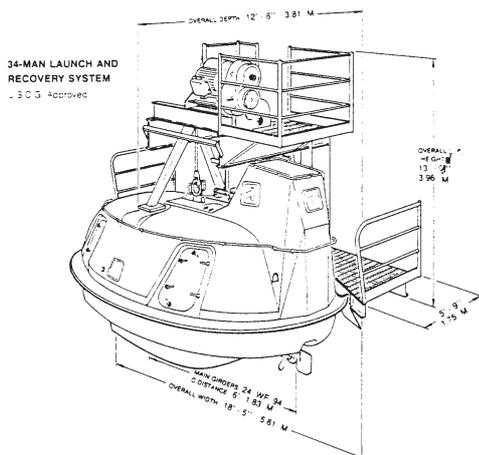


Figure 8.1 Survival Systems International (PL34) launch and recovery system.



31. Survival Systems International operational at sea in active training capacity.

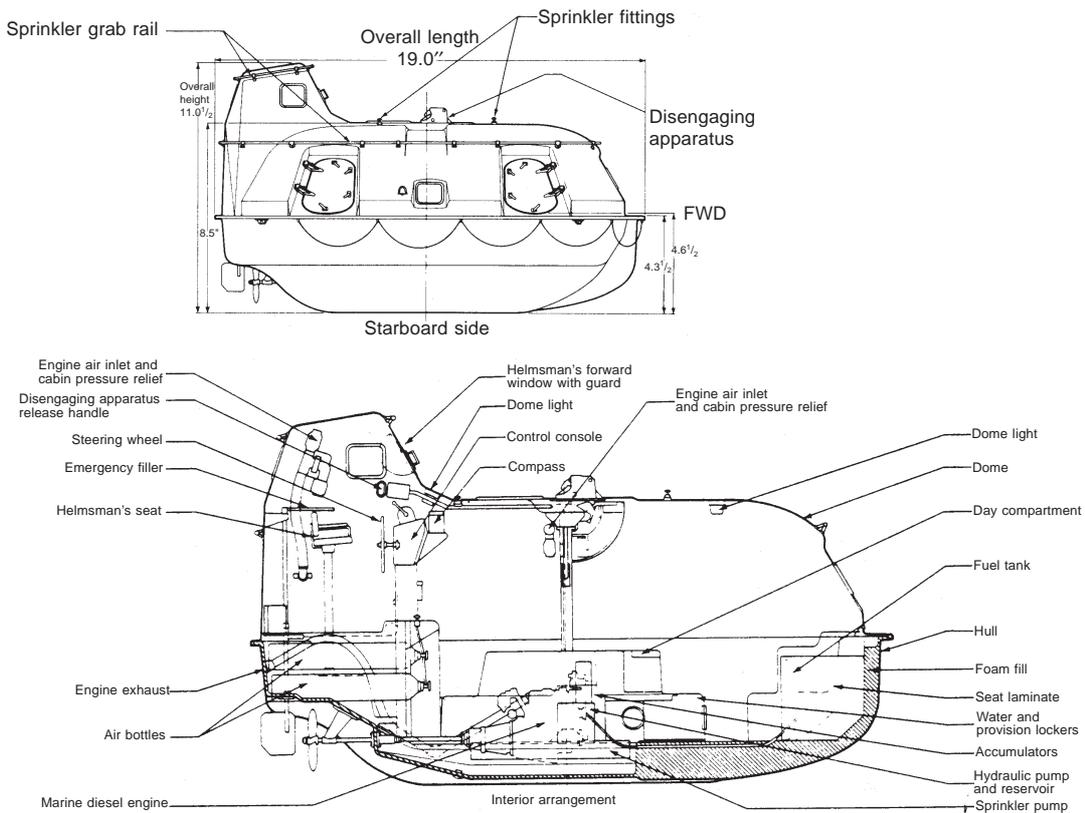


Figure 8.2 Survival Systems International arrangement - 34 man size.

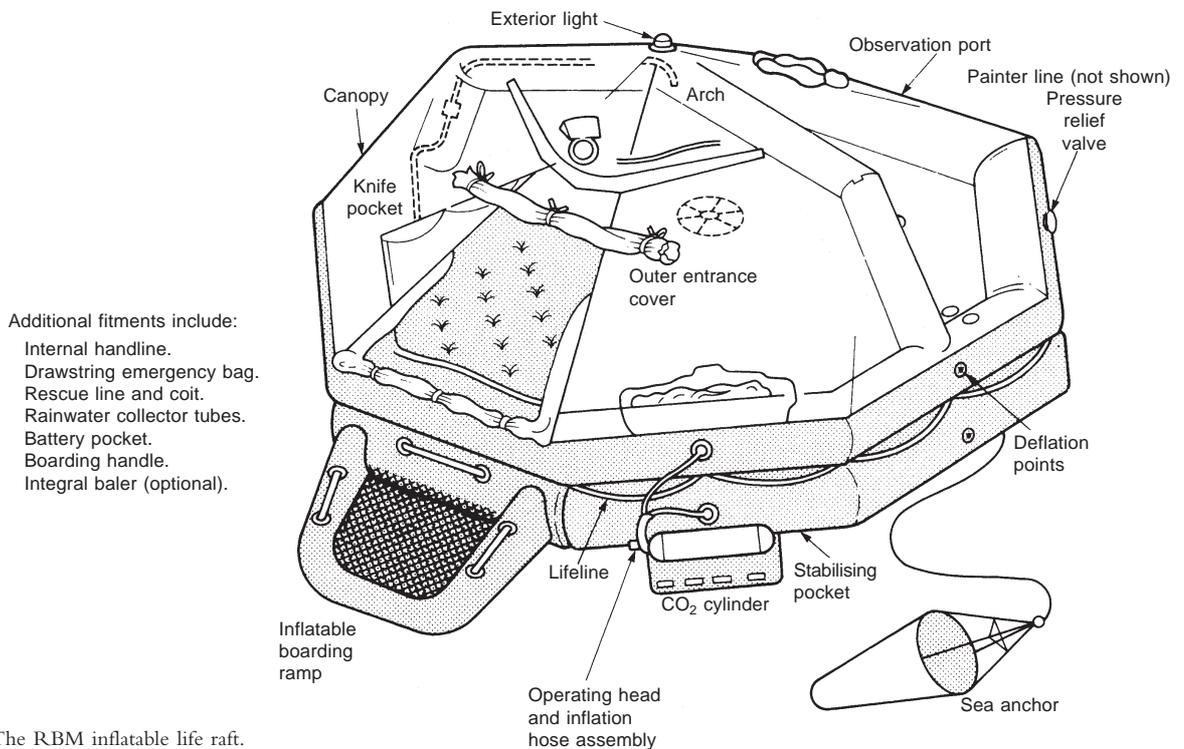


Figure 8.3 The RBM inflatable life raft.

Every life raft should be capable of withstanding exposure for 30 days of sea conditions. This is not to say that provisions and water would last for this period of time. Standard rafts should be robust in construction to be launched from a height of 18 m and when inflated be able to withstand repeated jumps on to its surface from heights up to 4.5 m.

The main buoyancy chamber should be divided into two compartments each being inflated via a non-return valve. Each compartment should be capable of supporting the full complement of the raft in the event of damage to either buoyancy chamber.

The canopy should protect the occupants from exposure and should automatically set in place when the raft is launched. It should protect from heat and cold by two layers, separated by an air gap, and means to prevent water accumulating inside the air gap. The exterior should be of a highly visible colour while the interior colour should not cause discomfort to the occupants.

It should be provided with rain catchment area(s) and with at least one viewing port. Entrances should be clearly indicated and fitted with efficient adjustable closing arrangements. A ventilation system should be provided which allows the passage of sufficient air but excludes the passage of sea water and cold.

General particulars regarding the overall construction of the raft should include sufficient headroom for sitting occupants under all parts of the canopy. All materials used in the manufacture should be: rot proof, corrosive-

resistant, unaffected by sunlight and not duly affected by sea water, oil or fungi attack. Retro-reflective material should be prominently displayed to assist in detection of the raft.

Life Raft Fittings

The fittings should permit the raft to be towed at a speed of 3 knots in calm waters, when loaded with its full complement and having one of its 'sea anchors' streamed (towing bridle/patch). Provision will also be available for the siting and securing of the radio antenna, together with becketed lifelines both inside and outside every life raft.

The total weight of each raft, unless it is to be launched by an approved launching device, will not exceed 185 kg, inclusive of the case and all fitments.

Inflation of the life raft should be with a non-toxic gas and should take place within a period of 1 minute when at an ambient temperature of between 18°–20°C or within a 3 minute period at a temperature of –30°C. Normal practice to cause inflation is by 'tugging' on the painter line. The painter's length should be not less than twice the distance from the stowed position to the waterline, when the vessel is at its lightest sea-going condition.

The floor of the raft may inflate automatically, but provision must be made for deflation and inflation of the floor by the occupants, in order to provide insulation for the occupants.

Illumination

This shall be provided by a manually controlled lamp, fitted to the top of the life raft canopy visible on a dark night with a clear atmosphere at a distance of at least 2 miles for a period of not less than 12 hours. If the light is a flashing light it shall flash at a rate of not less than 50 flashes per minute for the first 2 hours of operation of the 12 hour period. The lamp shall be provided by power from either a sea-water activated cell or a dry chemical cell and shall automatically light when the raft inflates. The cell shall be of a type that does not deteriorate due to damp or humidity inside the stowed life raft.

A manually controlled lamp shall be fitted inside the life raft capable of continuous operation for a period of at least 12 hours. This lamp will light automatically when the life raft inflates. Its intensity should be sufficient to allow the reading of the survival instructions.

Access and Boarding of Inflatable Life Raft

Every life raft which accommodates more than eight persons must have at least two entrances, which are diametrically opposite. One of these entrances must be fitted with a semi-rigid boarding ramp to allow persons to board from the sea. Past experience has shown that survivors wearing standard bulky lifejackets found extreme difficulty in boarding the raft from the water, especially after using valuable energy in swimming towards the craft.

Entrances which are not provided with the ramp should be fitted with a boarding ladder, the lowest step being situated not less than 0.4 m below the raft's lightest waterline. Means should also be provided inside the raft to allow people to pull themselves into the raft from the ladder.

Capacity of Life Rafts

The number of people which a life raft shall be permitted to accommodate shall be equal to the lesser of:

1. the greatest whole number obtained by dividing by 0.096 the volume measured in cubic metres of the main buoyancy tubes (which for this purpose shall include neither the arches nor the thwarts if fitted) when inflated; or
2. the greatest whole number obtained by dividing by 0.372 the inner horizontal cross-sectional area of the life raft measured in square metres (which for this purpose may include the thwart or thwarts if fitted) measured to the innermost edge of the buoyancy tubes; or
3. the number of persons having an average mass of 75 kg all wearing lifejackets, that can be seated with sufficient comfort and headroom without interfering with the operation of any of the life raft's equipment.

Markings on the Life Raft

Each life raft should carry the following markings:

- (a) the makers name or trade mark;
- (b) a serial number;
- (c) the date of manufacture;
- (d) the name of the approving authority;
- (e) the name and place of servicing station where it was last serviced;
- (f) the number of persons it is permitted to accommodate over each entrance in characters not less than 100 mm in height of a contrasting colour to that of the raft.

Life Raft Equipment

1. One buoyant rescue quoit, attached to not less than 30 m of buoyant line. Used to assist the recovery of additional survivors.
2. One safety knife of the non-folding type, having a buoyant handle and lanyard attached. It should be stowed on the exterior of the canopy near to that point to which the painter is secured.

In addition, a life raft which is permitted to accommodate 13 persons or more shall be provided with a second knife which need not be of the non-folding type.

3. One buoyant bailer for every life raft which is permitted to accommodate not more than twelve persons. Two buoyant bailers for life rafts which accommodate thirteen persons or more.
4. Two sponges, one being theoretically for drying out the floor of

the raft, while the other may be used to collect condensation from the inner canopy.

5. Two sea anchors, often called drogues. Each fitted with a shock resistant hawser and tripping line. The strength of hawsers and tripping lines should be adequate for all sea conditions. Sea anchors shall be fitted with swivels at each end of the line and will be of a type that is unlikely to foul inside out between its shroud lines. One of the sea anchors should be permanently secured in such a manner that when the life raft inflates it will be caused to lie orientated to the wind in the most stable of manners.

The purpose of the drogues is to restrict the drift rate of the life raft and reduce the risk of capsize. It is especially required if the life raft is engaged in helicopter operations.

6. Two buoyant paddles, used to assist the manoeuvring of the raft away from the ship's side. It should be noted that it is extremely difficult to give directional force to a circular raft by use of the paddles alone and seafarers may find it more helpful to weight the sea anchor and throw it in the direction in which the raft is required to travel, so drawing the raft through the water towards the drogue. The paddles may also make useful splints for administration of first aid to possible broken limbs of injured parties.
7. Three tin openers. These may be incorporated with the safety knives.
8. One whistle or equivalent sound signal.
9. Two buoyant smoke signals.
10. Four rocket parachute flares.
11. Six hand-held flares.
12. One waterproof electric torch, suitable for morse signalling. It should be supplied with one spare set of batteries and one spare bulb, in a waterproof container.
13. One efficient radar reflector.
14. One heliograph (daylight signalling mirror). This is a silvered sheet of metal which fits into the operator's hand. It is used to reflect the sun's rays in the direction of a potential rescue aircraft or surface vessel. In marine use it is a means of attracting attention and it would be extremely unlikely that the instrument could be used to transmit morse code successfully from a small boat or raft which would probably be moving in an erratic manner in swell and/or sea.
15. One set of fishing tackle, usually comprising a fishing line and six hooks. Any fish caught should be treated with reserve as it may be of a poisonous variety. Fish, in any case, are not recommended to be eaten unless a plentiful supply of water is available. Should the raft become badly torn fishing gear can be used for repair.
16. One copy of the lifesaving signals, referred to in Regulation V/16, on a waterproof card or in a waterproof container.
17. Thermal protective aids which comply with Regulation 34, in sufficient numbers for 10 per cent of the people that the life raft is permitted to accommodate, or two, whichever is the greater.

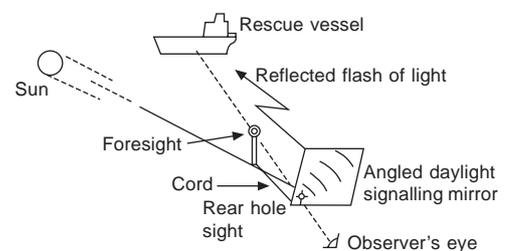


Figure 8.4 Use of heliograph.

18. A food ration totalling not less than 10,000 kJ for each person the life raft is permitted to accommodate. These rations should be contained in airtight packages and stowed in watertight containers.
19. Fresh water in watertight receptacles amounting to 1.5 litres per person that the raft is permitted to accommodate, of which 0.5 litres per person may be replaced by a de-salting apparatus capable of producing an equal amount of water in two days.
20. One rustproof graduated drinking vessel (usually plastic).
21. One set of instructions on survival.
22. One set of instructions on immediate actions.
23. Six doses of anti sea-sickness medicine (sea-sick tablets) and one sea-sickness bag for each person the raft is permitted to accommodate.
24. One first aid outfit in waterproof case capable of being closed tightly after use.



32. Rack stowage of inflatable life rafts aboard a passenger vehicle ferry.

Outline of the contents of basic first aid kit:

- (a) collapse revivors (6 capsules of fragrant ammonia) contained in a tin;
- (b) 25 compound codeine tablets;
- (c) 2 standard dressings 6 in. × 4 in.;
- (d) 2 standard dressings 8 in. × 6 in.;
- (e) elastic adhesive dressings, 2 packs of three (2 in. × 3 in.);
- (f) 5 triangular bandages, not less than 38 in. sides and 54 in. base;
- (g) 3 pieces of white absorbent gauze (36 in. × 90 in.);
- (h) 4 compressed roller bandages (2¹/₂ in. × 144 in.);
- (i) calico bandage, unbleached (6 in. × 18 ft);
- (j) 1 packet of compressed cotton wool (4 oz);
- (k) 6 safety pins;
- (l) 1 tube of soft petroleum jelly;
- (m) 1 pair of scissors, stainless steel;
- (n) 60 energy tablets;
- (o) 1 set of instructions;
- (p) 1 capsule of silica gel, to keep the contents dry and free of moisture.

Inflatable life rafts must carry in addition a repair outfit for repairing punctures to the buoyancy chambers and a topping up pump or bellows.

Markings on the Container of the Life Raft

Each life raft container shall be marked with;

- (a) the maker's name or trade mark;
- (b) serial number;
- (c) name of the approving authority and the number of persons it is permitted to carry;
- (d) SOLAS;
- (e) the type of emergency pack enclosed in the raft;
- (f) the date when last serviced;
- (g) length of painter;
- (h) the maximum permitted height of stowage above the waterline, (dependent on the drop test height and length of painter);
- (i) the launching instructions.

LAUNCHING INFLATABLE LIFE RAFT

The web straps securing the raft in its stowage cradle should be released by slipping the manually operated senhouse slip. The raft container should then be manhandled to the launching position by the ship's side. If side rails are in position, these should be removed to facilitate the launch.

The painter from the raft should be checked to see that it is well secured to a strong point of the vessel. Where a hydrostatic release unit is fitted, the painter and 'D' ring should be inspected to ensure that they are well fast.

Pull out a limited amount of the painter from the container, check that the water surface is clear of other survivors, or debris, then throw the raft away from the ship's side. Inflation will be caused by a sharp 'tug' on the fully extended painter, causing the CO₂ gas bottle to be fired.

BOARDING RAFT

Seafarers should endeavour to board the raft while they are dry, should they try to jump directly into the raft from a greater distance than 2 m, they may cause serious damage to the raft, other occupants and to themselves.

Precautions

Before boarding the raft, remove all heavy shoes, sharp objects etc. from the person to prevent accidental puncture of the fabric. Once inside the raft, check for leaks and ensure that excess carbon dioxide gas is vented clear of the inner canopy.

Mariners should always remember to try to board in the dry condition.

RIGID LIFE RAFTS

All rigid life rafts shall comply with the general requirements specified by the regulations regarding life rafts.

Construction

The buoyancy of the rigid life raft shall be provided by approved inherently buoyant material placed as near as possible to the periphery of the life raft. The buoyant material shall be fire retardant or be protected with fire retardant covering.

The floor of the raft shall prevent the ingress of water and shall effectively support the occupants out of the water and insulate them from cold. The stability being such that unless it is capable of operating safely whichever way up it is floating, it must be either self-righting or can be readily righted in a seaway and in calm water by one person. Once loaded with its full complement of persons and equipment it must be possible to tow the raft in calm water at a speed of up to 3 knots.

Access into the Rigid Life Raft

At least one entrance shall be fitted with a rigid boarding ramp to enable persons to board the raft from the sea. In the case of Davit launched life raft having more than one entrance, the boarding ramp shall be fitted at the entrance opposite to the bowing and embarkation facilities. Entrances not provided with a boarding ramp shall have a boarding ladder the lowest step of which shall be situated not less than 0.4 m below the life raft's lightest waterline. There should also be means inside the raft to assist persons to pull themselves inside from the ladder.

Capacity

The number of persons that the life raft is permitted to accommodate shall be equal to the lesser of:

- (a) the greatest whole number obtained by dividing by 0.096 the volume measured in cubic metres of the buoyancy material multiplied by a factor of 1 minus the specific gravity of the material; or
- (b) the greatest whole number obtained by dividing by 0.372 the horizontal cross sectional area of the floor of the life raft measured in square metres; or
- (c) the number of persons having an average mass of 75 kg, all wearing lifejackets, who can be seated with sufficient comfort and headroom without interfering with the operation of any of the life raft's equipment.

Fittings

The life raft shall be fitted with a painter system, the breaking strength of which, inclusive of its means of attachment and excepting any weak link required, shall be not less than 10.0 kN, for rafts permitted to accommodate nine persons or more, and not less than 7.5 kN for other rafts.

They should also have a manually controlled lamp, visible at a distance of at least 2 miles, fitted to the top of the raft canopy, and capable of 12 hours operation. If this is a flashing light it should operate at not less than 50 flashes per minute for the first 2 hours of the 12 hour period. The lamp should be powered by a sea activated cell or a dry chemical cell which shall automatically light when the canopy is set in place. This cell should not deteriorate due to dampness or humidity, while in stow.

A manually operated lamp should also be positioned inside the life raft capable of at least 12 hours operation and activated automatically.

Markings on Rigid Life Raft

The life raft shall be marked with the following:

1. the name and port of registry of the ship to which it belongs;
2. the maker's name or trade mark;
3. a serial number;
4. the name of the approving authority;
5. the number of persons it is permitted to accommodate over each entrance in characters not less than 100 mm in height of a colour contrasting with that of the life raft;
6. SOLAS;
7. the type of emergency pack enclosed;
8. length of painter;
9. the maximum permitted height of stowage above the waterline (drop test height);
10. launching instructions.

THE DAVIT LAUNCHED LIFE RAFT

Every davit launched life raft shall comply with the general requirements regarding life rafts, and in addition, Davit launched rafts shall be used with an approved launching appliance and shall:

- (a) when the life raft is loaded with its full complement of persons and equipment, be capable of withstanding a lateral impact against the ship's side at an impact velocity of not less than 3.5 m/s and also the drop into the water from a height of not less than 3 m, without damage that will affect its function.
- (b) be provided with the means for bringing the life raft alongside the embarkation deck and holding it securely during embarkation.

Every *passenger* ship davit launched life raft shall be so arranged that it can be boarded by its full complement of persons. Every *cargo* ship davit launched life raft shall be so arranged that it can be boarded by its full complement of persons in not more than 3 minutes from the time the instruction to board is given.

Davit Launched Inflatable Life Rafts

When suspended from the lifting hook or bridle shall withstand a load of:

- (a) 4 times the mass of its full complement of persons and equipment at an ambient temperature and a stabilised raft temperature of $20^{\circ} \pm 3^{\circ}\text{C}$, with all relief valves inoperative; and
- (b) 1.1 times the mass of its full complement of persons and equipment at an ambient temperature and a stabilised raft temperature of -30°C , with all relief valves operative.

Rigid containers for life rafts to be launched by a launching appliance shall be so secured that the container or parts of it are prevented from falling into the sea during and after inflation and launching of the contained raft.

Davit Launched Rigid Life Rafts

A rigid life raft for use with an approved launching appliance shall, when suspended from its lifting hook or bridle, withstand a load of 4 times the mass of its full complement of persons and equipment.

Davit launched survival craft muster and embarkation stations shall be so arranged as to enable stretcher cases to be placed in the survival craft. They shall also be stowed within easy reach of the lifting hooks, unless some means of transfer is provided which is not rendered inoperative within the limits of trim and list specified by the regulations.

Where necessary, means shall be provided for bringing the davit launched life raft against the ship's side and holding it alongside so that persons can be safely embarked.

Every life raft launching appliance shall comply with the general requirements (paragraphs 1 and 2) for launching appliances except with



33. Davit launched life raft, bowsed in and ready to embark personnel.

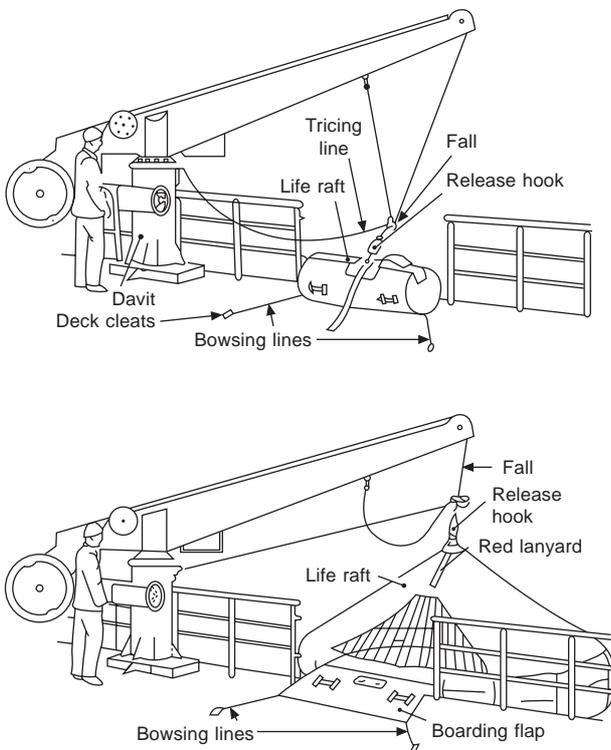


Figure 8.5 (a) Davit launched life raft procedure.

regard to use of gravity for turning out the appliance, embarkation in the stowed position and recovery of the loaded raft. The arrangement should not allow premature release during lowering and shall release the raft when waterborne.

Comment on Davit Launched Life Raft

The davit launched life raft system is designed to be a speedy method of evacuation for would-be survivors. The obvious advantage over the inflatable raft being that persons can board in the dry condition without running the risk of having to enter the water, bearing in mind that the body loses heat approximately 26 times faster in water than when in a dry condition. Also casualties can be lifted directly into the raft at the embarkation deck level without the risks of getting close to the surface.

Its operation usually takes the form of several rafts stowed in racks. These can all be launched by recovery of the fall/release hook by means of the tricing line without the necessity for turning the davit inboard for each raft. The fall returning to embarkation deck level after each launch by the winch.

Great care should be taken with every system and the manufacturer's instructions closely followed. The real danger of confusing similar types of systems and causing inflation at the wrong moment could cause bowsing lines to part and damage the raft and render the raft incapable for use in the intended way.

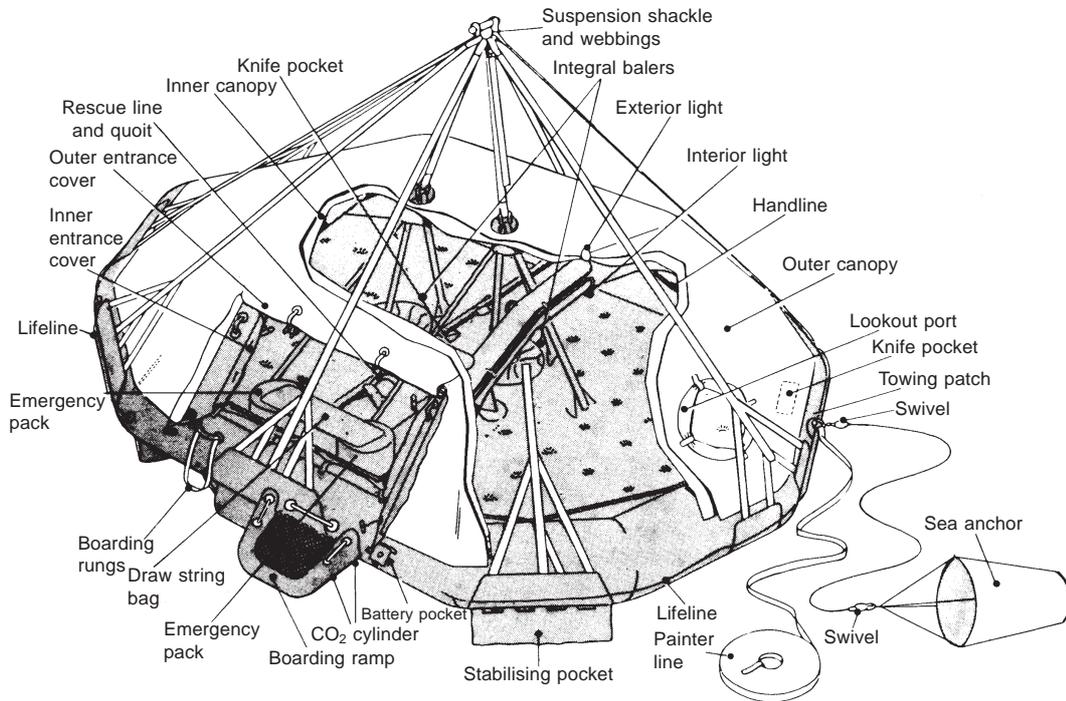


Figure 8.5 (b) Beaufort davit launched inflatable life raft.

Procedure for Launching Davit Launched Life Raft

The mariner's attention is drawn to the following guidelines for launching davit launched life rafts. The text should only be accepted in a general form as the methods of launch will vary depending on the size and manufactured type of raft/davit. It is also pointed out that different manufacturers have a wide range of fitments which are not necessarily carried on all rafts, and may be described by different names.

1. (In the case of the first raft to be launched) transfer the life raft to a position under the davit head, so that the fall plumbs the raft container.
2. Walk back the fall and secure the release hook to the shackle/ring, extracted to protrude from the life raft container. Check that the release hook is locked and armed.
3. Remove any side rails and check that the overside surface area is clear of obstructions.
4. Pull out the painter line/lines and secure to a strong point.
5. Pull out the bowing lines and secure to a strong point.
6. Pull out left and right container restraining lines, if fitted, and secure to the mother ship. (Valise type life rafts do not have these lines.)
7. Hoist the life raft on the fall to inflation height and slew the davit overside to the stop position.

8. Inflate the raft by pulling out the full length of painter.
9. Take up any slack on the bowsing lines to hold the raft alongside and secure any boarding flap.
10. Check that the raft has no defects and that it is well ventilated.
11. Check that personnel have no sharp objects on their person, then board the raft keeping it stable.
12. Release the boarding flap and the bowsing lines and throw them into the entrance of the raft.
13. Check the overside is still clear and lower the life raft.
14. Cock the release hook by means of the operating lanyard when the life raft is close to the water surface (within about 10 feet).
15. The raft should be automatically released once the raft becomes waterborne and its weight is removed from the bearing surface of the hook by the buoyancy effects on the raft.
16. The painter should be cut or released and the life raft quickly manoeuvred away from the ship's side.

Once clear of the immediate area life rafts should be joined together with about a 10 m length between to avoid snatching in a seaway.

Mills Atlas Release Hook

In this release mechanism (Figure 8.6) designed for use with the davit-launched life raft, each hook is subjected to a static load test of just over $5\frac{3}{4}$ tonnes (5842 kg), while the safe working load of the unit is just over $2\frac{1}{4}$ tonnes (2286 kg). The operating lanyard is tested separately by a static load test of 500 lb (227 kg).

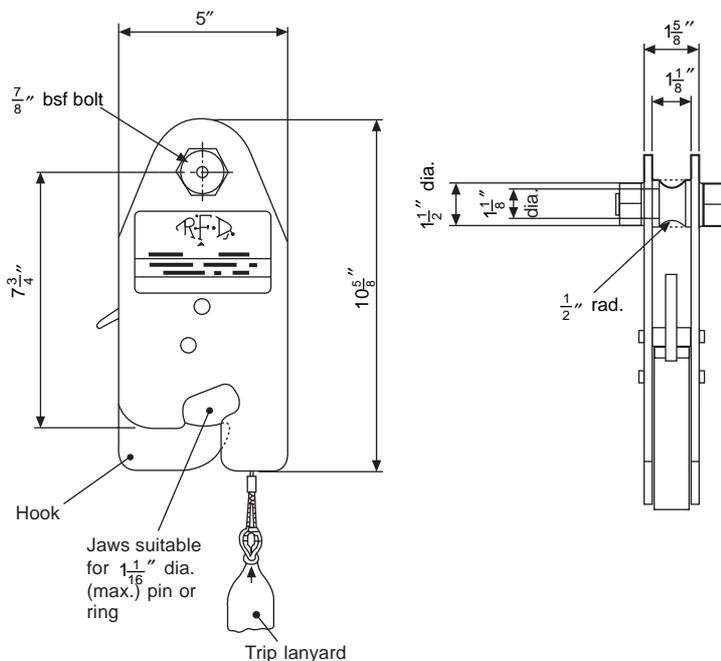


Figure 8.6 Securing of davit launched life raft.

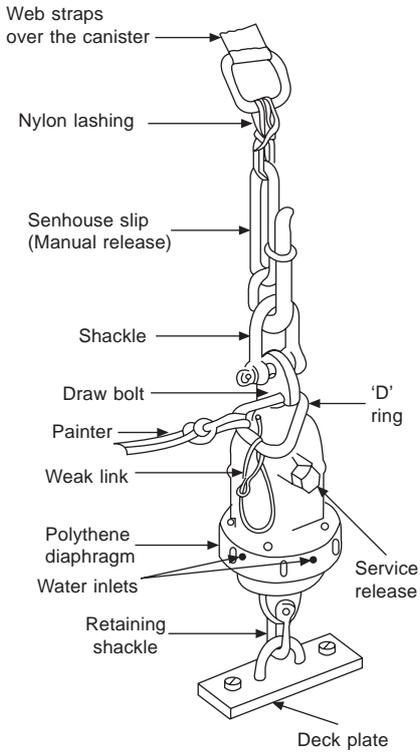


Figure 8.7 Hydrostatic release unit.

The hook unit is secured to the shackle protruding from the valise and locked in position by means of an internal safety catch. When the raft starts to descend, the lanyard can be operated from within the raft. This lanyard only unlocks the safety catch, and the hook will not release the raft until the raft itself becomes waterborne.

The principle of operation is that the weight of the raft maintains the hook in the closed position. However, when the load suspended from the hook, namely the raft, falls below 30 lb (13.5 kg), the hook is allowed to open, so releasing the raft. The apparent loss in weight of the raft is effective as soon as it becomes waterborne.

Hydrostatic Release Unit (HRU)

The hydrostatic release unit (Figure 8.7) is an extension of the securing lashings over the inflatable life raft. The lashing itself must incorporate a senhouse slip to allow manual release.

Should the vessel suffer a disaster and subsequently sink, then the release unit will automatically activate under the surface of the water, at not more than 4 m depth, when the pressure is sufficient to release the draw bolt. Once the draw bolt is released, the web strap lashing no longer retains the raft canister in its cradle support. The life raft is free to float to the surface, extracting the length of painter as it rises clear of the sinking vessel.

The painter is secured to a 'D' Ring, which was previously retained by the draw bolt, the arrangement providing a weak link securing which will part after the painter becomes fully extended and the pressure increases, causing the safe working load/breaking strain to be exceeded.

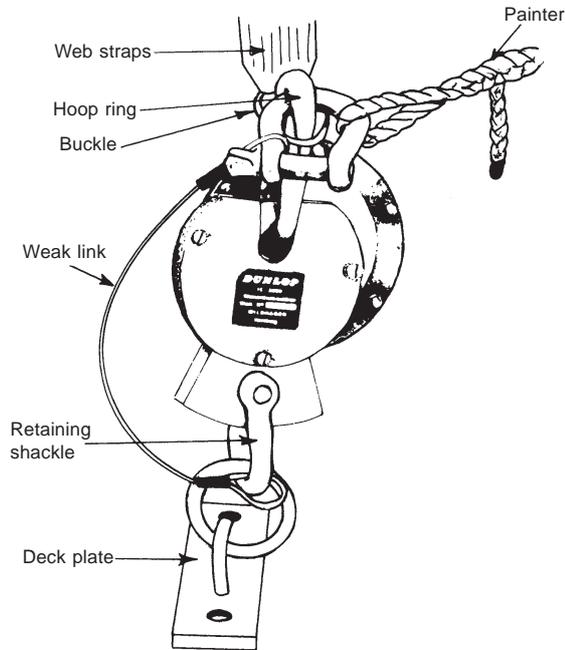
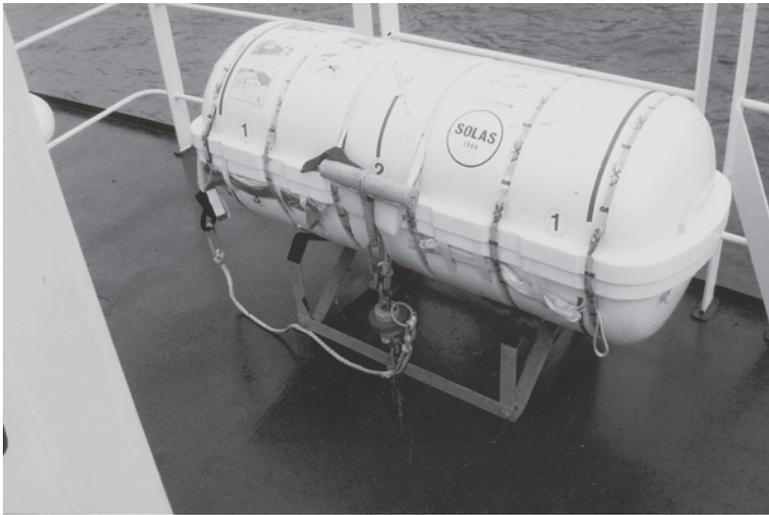


Figure 8.8 Dunlop hydrostatic release unit.



34. Inflatable life raft stowed in cradle and fitted with hydrostatic release unit.

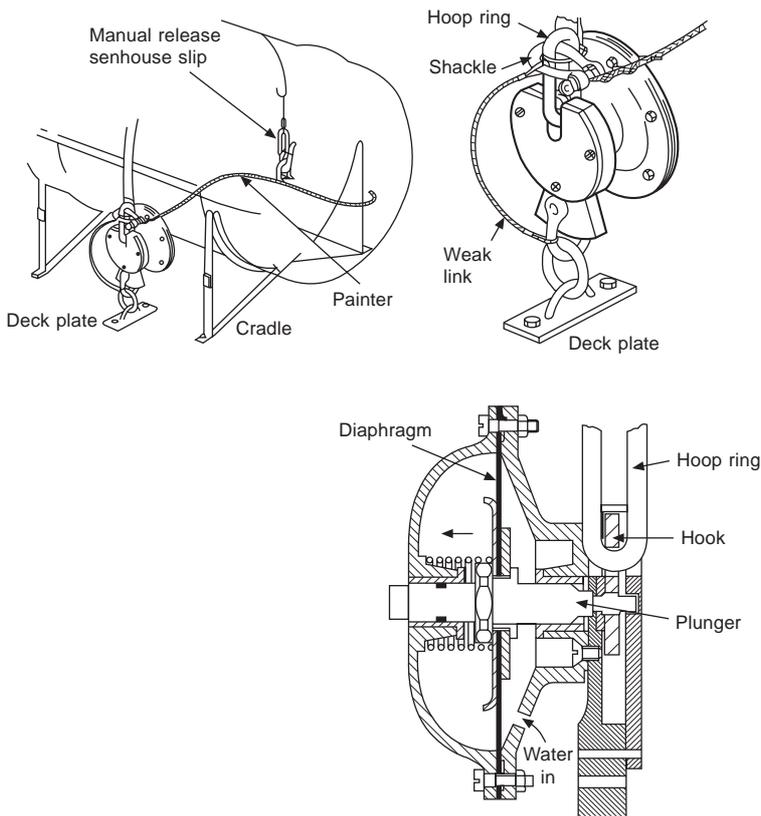


Figure 8.9 Dunlop HRU. When the unit is submerged, water fills one chamber and pressure in excess of the spring loading causes the diaphragm to move sideways, which withdraws the plunger from engagement with the hook. Tension on the associated lashing causes the hook to rotate, releasing the hoop ring and allowing the raft to float free.

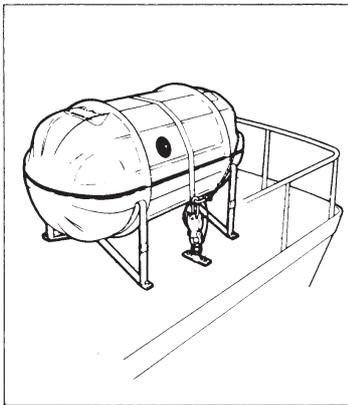
Increased tension on the painter/weak link components will effectively cause inflation of the raft, provided that the vessel continues to sink further. The raft would not become inflated if the vessel sank and settled on the sea bed at a depth less than the length of the painter; and inflation

would take place on the surface only when the painter is fully extended and the canister started to 'snatch' over the painter's length.

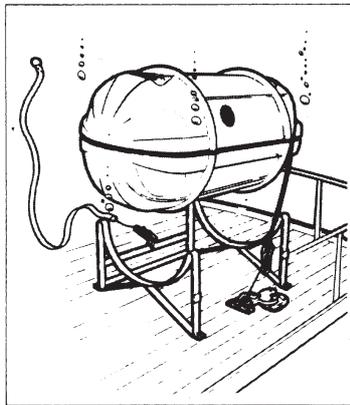
By releasing the senhouse slip arrangement the raft may be launched manually and inflated in the normal manner, or released for despatch ashore for annual servicing.

Float Free Arrangements for Life Rafts

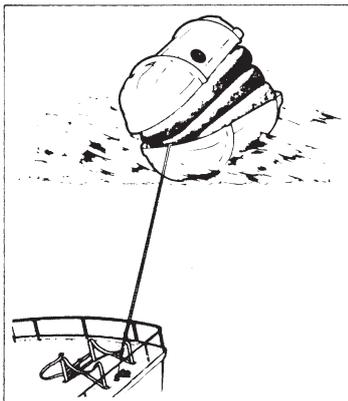
1. The breaking strength of the painter system, with the exception of the weak link arrangement shall be not less than 10.0 kN for rafts carrying nine persons or more and not less than 7.5 kN for other life rafts.
2. A weak link system, if used, shall break under a strain of 2.2 ± 0.4 kN.



A life raft on a typical stowage showing the painter line made fast to the weak link system of the H.R.U. Note that the location is such that the senhouse slip is readily accessible and that the H.R.U. is on the seaward side of the vessel



When submerged to a depth of 1.5 to 3.7 metres (5 to 12 feet), the H.R.U. operates automatically. Freed of its lashing strap, the container rises to the surface paying out the inflation painter line as it goes but retaining it to the H.R.U. by means of the weak link



It is this combination of the rising container and the sinking vessel which provides the painter tension which activates the gas cylinder and starts inflation once all the free painter line is paid out



As the vessel continues to sink, the weak link will break thus releasing the life raft from the vessel. The weak link of 227 ± 45 Kg (500 \pm 100 lb) breaking strength ensures that a raft is not dragged under by the sinking vessel before it has time to inflate to its full dimensions

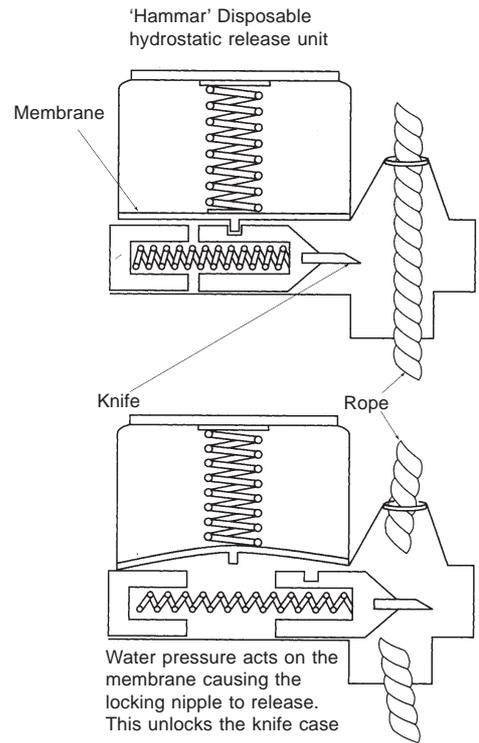


Figure 8.10 Hydrostatic release unit – how it works. NB: Disposable hydrostatic release units are now available. These have an active life cycle of two years and are then replaced.

3. Any weak link should not be broken by the force required to pull the painter from the raft. If applicable, the weak link should be of sufficient strength to permit inflation of the raft.
4. Hydrostatic release units, if used, should not release the raft when seas wash over the unit and they should be fitted with drains to prevent water accumulation inside the hydrostatic chamber.
5. Release units should be constructed of compatible material so as to prevent malfunction. Galvanising or other forms of metallic coating on parts of the hydrostatic release unit shall not be accepted.
6. The life raft should be permanently marked on the exterior with its type and serial number.
7. Either a document or identification plate stating the date of manufacture, type and serial number will be provided.
8. Any part connected to the painter system shall have a strength of not less than that required for the painter.

The mariner should note that where a survival craft requires a launching appliance and is also designed to float free, the float free release of the survival craft from its stowed position should be automatic.

Servicing of Hydrostatic Release Units

Hydrostatic release units shall be serviced at intervals not exceeding 12 months. However, in cases where it appears proper and reasonable, the Authority may extend this period to 17 months. Servicing must be carried out at a competent servicing station, by properly trained personnel.

ADDITIONAL FITMENTS TO RAFT

Water Catchment Areas

These are situated on the outer canopy to collect rainwater and supplement the basic water ration supplied with the raft. The catchment areas will differ in shape from manufacturer to manufacturer but the purpose of each is the same, to collect rainwater and deliver it to a collection tube inside the life raft. Survivors should be careful to wash off any salt content from the catchment area before drinking the newly acquired rainwater.

Double Doorway Entrance

The covering over the entrance is manufactured as two separate sheets of weatherproof fabric, the outer cover being rolled down and secured to the buoyancy chambers by Velcro strips or tape positioned at intervals across the raft entrance. The inner cover is opened upwards from the buoyancy chamber to be secured inside the upper canopy of the raft by a toggle. The inner cover will have two water pockets, one at each side, equipped with a draw string. The purpose of the water pockets is to allow any water being bailed from the raft to be expelled over the side without opening up the entrances and losing the internal warmth of the raft.

NB. Different type of Liferaft are now found within the marine environment. These include the 'Heli-raft' used extensively by aircraft and open reversible rafts by High speed Craft. Other examples are in use with MES & MEC Operations.

ABANDONING SHIP

The order to abandon the vessel will be passed by word of mouth from the Master, or the most senior officer, but this order will only be given as the very last resort. It should be borne in mind that the mother ship is the very best life support craft available to you, and it should only be left when all hope of remaining safely afloat has been lost.

After the order has been passed to abandon the vessel, apprehension with regard to the future will be the main source of concern to all. Survival craft should be prepared for launch if time allows, and the vessel should be manoeuvred to a suitable position to permit safe launching. Headway on the vessel should be reduced, and, if possible, taken off completely, to allow safe launching of survival craft.

Once survival craft are in the water the following actions and procedures should take place:

Initial Vital Actions to Protect Against Exposure	<ol style="list-style-type: none"> 1. Cut painter 2. Stream drogue 3. Close entrance 4. Maintain craft 	} so far as possible simultaneously in group situations.
<i>Cold climates</i>		
CUT painter	Assist other survivors to board craft. Use safety knife provided. Manoeuvre clear from ship's side or obstructions.	
STREAM drogue	Reduces the rate of drift – allows survivors to reach craft – helps keep craft at location of casualty – ideally holds entrances at angle to weather – helps to prevent capsizing.	
CLOSE entrance	Keeps out water (sea or rain) and wind. Allows natural body heat of survivors to warm interior air. When warm and atmosphere heavy and uncomfortable, adjust ventilation. A very small opening should be sufficient.	
MAINTAIN craft	Insulation – Inflate the floor of the raft. Seaworthiness – Remove excessive water. Check for damage. Repair or plug if necessary. Check position of inflation (topping up) valves.	
Tropical climates	It is unlikely that it will be necessary to close up or insulate. It will be necessary to keep cool and avoid exposure to the sun. However, keep water out.	
Secondary vital actions	The above are essential actions to combat exposure. The following actions should also be taken as soon as possible (they are not necessarily in priority order).	
Seasick remedy	Life rafts in particular are known to make even the best sailors seasick. Seasickness is incapacitating and may destroy the will to survive, and to carry out survival procedure you need to be physically fit and mentally capable. It is therefore IMPERATIVE to take seasickness pills as early as possible. Seasickness is not only a physical handicap, but valuable body fluid may be lost. The pills themselves will make your mouth feel dry, but resist the urge to drink.	

Injured survivors	Maintain a clear airway; control bleeding. Treat injured survivors using the first aid kit. Instructions for use are included.
Bail out	Remove any water with bailer and dry out with sponges.
Warming up	If men are chilled or shivering, get everybody to huddle together but do not upset trim – the closer they get, the warmer they get. Cover with spare clothing. Sit on lifejackets as extra insulation if necessary. Loosen any constriction on feet. Keep wriggling toes and ankles to reduce chance of getting cold injuries. Change lookouts if necessary to prevent frostbite on exposed skin.
Congregation of rafts	Join up and secure with other craft – mutual aid. In cold weather, get maximum numbers together for warmth. Two or more craft are easier to find than one.
Search for survivors, lookout	Listen for whistles: post lookouts to look for survivors, signalling lights and lights of other rafts, ships or aircraft. Lookout to collect useful debris etc. Assist survivors by using the quoit and line, thereby avoiding swimming. Raft may be manoeuvred using drogue or paddle.
Handbook	Read the survival craft handbook for further guidance on actions to be taken etc.
Morale and will to survive	Cold, anxiety, hunger, thirst, effects of seasickness all work against the will to survive. Keep spirits up. Maintain confidence in rescue. Firm but understanding discipline. Keep a lookout for signs of abnormal behaviour and avoid doing things which annoy others. Delirious people. Physically restrain. Bear in mind effect on other survivors.

Subsequent actions	The initial and secondary actions combat the immediate threats to survivors. This section concerns subsequent actions and survival craft routine.
Leader	Appoint or elect a leader.
Sharp objects	Collect sharp objects or potential weapons.
Roll call	Have a roll call to muster survivors.
Routine	Establish a routine and allocate duties to survivors – ration keeper – lookouts – repair party – bailers etc. It is important to keep the minds of survivors occupied while avoiding unnecessary exertion.
Watches	One hour watches in pairs – one outside and one inside. <i>Duties</i> Outside – Lookout for ships, survivors, aircraft etc. – Gather useful wreckage. Inside – Maintain raft (bailing, drying, ventilation, buoyancy tubes etc.). Supervise raft management while others rest. – Attend to injured persons. – Look after equipment, valuables etc.
Raft management Protection	<i>Cold climates</i> Keep warm and dry. Adjust ventilation to minimum required. Huddle together for warmth if necessary. Carry out simple

	<p>exercises to avoid cold injury: open and clench fists, stretch limbs; wriggle toes, ankles, fingers, wrists. This will maintain circulation but not waste energy. Avoid exposure – rotate lookout to avoid exposure.</p> <p><i>Hot climates</i></p> <p>Arrange ventilation.</p> <p>Avoid exposure (sunburn).</p> <p>Reduce need for water by – avoiding unnecessary exertion (no swimming)</p> <ul style="list-style-type: none"> – maintain a through breeze – position of drogue? – keep outside of raft wet – wet clothing by day.
Location	<p>Keep lookouts. Have location aids readily available. Keep rafts congregated. Drogues or sea anchor will reduce rate of drift from casualty area.</p>
Water/food	<p>Issue rations <i>after</i> first twenty-four hours at set times during the day – sunrise, midday, sunset. Method of issuing rations. Collect rainwater whenever possible. Eat fish only if plentiful supply of water available. Precautions in hot weather – see 'Protection'.</p> <p>DO NOT ISSUE rations during first twenty-four hours except to injured people (if conscious). RAINWATER should be collected from the outset.</p>
Rations	<p>The rations provided in the craft are based upon the above knowledge and instructions for their use MUST BE FOLLOWED. The length of time that the rations will last will depend upon the number of occupants. However, the minimum with a full complement is 4 days.</p>
Issue of rations	<p>DO NOT ISSUE WATER DURING THE FIRST 24 HOURS.</p> <p>The body is already full of water – if more is put in it will be wasted in the form of urine. After 24 hours the body will be drier and will absorb any water that is drunk, just as a sponge will hold water but a wet sponge will not hold any more. Only if a man is injured is it permissible to give him a drink in the first 24 hours to replace fluid loss due to bleeding or burns and ONLY IF HE IS CONSCIOUS.</p> <p>After 24 hours, issue a full ration three times daily at sunrise, midday and sunset. Don't be tempted to give more rations than necessary. Make sure the carbohydrate food is taken. In prolonged survival, wait until the fourth day before reducing the daily ration if absolutely necessary and then only by half. It is essential to supplement rations with rainwater from the outset.</p>
Supplement rations	<p>Supplement the basic supply of water whenever you can. Rainwater should be retained. Condensation is a possible supply.</p>
Seawater/urine	<p>DO NOT DRINK SEAWATER OR URINE. Madness or death follow rapidly upon the drinking of seawater or urine.</p>
Fish flesh	<p>DO NOT EAT FISH FLESH unless you have an abundant supply of water. Protein foods such as fish tend to consume vital body fluids.</p>

Acknowledgment: The author would like to thank the Merchant Navy Training Board for their permission to reproduce part of the *Basic Sea Survival Course Instructors Manual*.

MARINE EVACUATION SYSTEM (MES)

Designed initially to provide an effective means of evacuating passengers and crew from high freeboard vessels of the ferry/passenger class into life rafts, the system consists of a double track inflatable slide with an integral boarding platform, mounted in a deck stowage container. The life rafts drop into the water adjacent to the platform (see Figure 8.11).

Each life raft can carry up to forty-five persons, and two are packed in a weathertight container made of glass reinforced plastic (GRP). These rafts are inflated from the boarding platform at the end of the slide, then linked to the platform by bowing in lines to facilitate safe boarding.

The operation starts with the removal of a cover in order to release an outboard door, which is unlocked from inside the ship, and the slide and platform are pushed away from the ship causing them both to inflate (see Figure 8.12). The inflating agent is a supply of nitrogen stored in cylinders in the deck-mounted container.

The boarding platform varies in diameter and is normally manned by crew members, who will secure the rafts to the sides of the platform before embarkation. The number of life rafts that the system can use may be adapted to the passenger-carrying capacity of the parent vessel.

In extreme emergency an inflated slide and platform can be released from the vessel to serve as an additional floatation aid for survivors. Each vessel is equipped with two systems, one on each side. New tonnage under construction is presently being fitted out with four systems, two each side. Regulations stipulate that total evacuation must take place within 30 minutes of the alarm being raised, and this system should more than meet these requirements.

EVACUATION-SLIDE LAUNCHING AND EMBARKATION

Every evacuation-slide system should conform to the general requirements for launching appliances, and in addition:

- (a) the evacuation slide shall be capable of being deployed by one person at the embarkation station;
- (b) the evacuation slide shall be capable of being used in high winds and in a seaway.

This is probably the latest innovation in sea survival techniques, being based on the rapid escape systems applicable to aircraft. The system which has been approved by the Department of Trade and Industry (Figure 8.11) becomes operational by activating a slide out from the ships side. This slide is variable in length and runs onto a landing platform, the platform being an integral part of the slide. Evacuation from the parent vessel takes place by persons sliding down the double trackway down to the landing platform, then embarking into 42/45 man life rafts.

The slide unit makes an angle of approximately 35° to the horizontal and is stowed in a box unit 8 ft \times ft \times 3 ft, weighing 8000 lbs. The compact unit is stowed at deck level and the number of life rafts will be

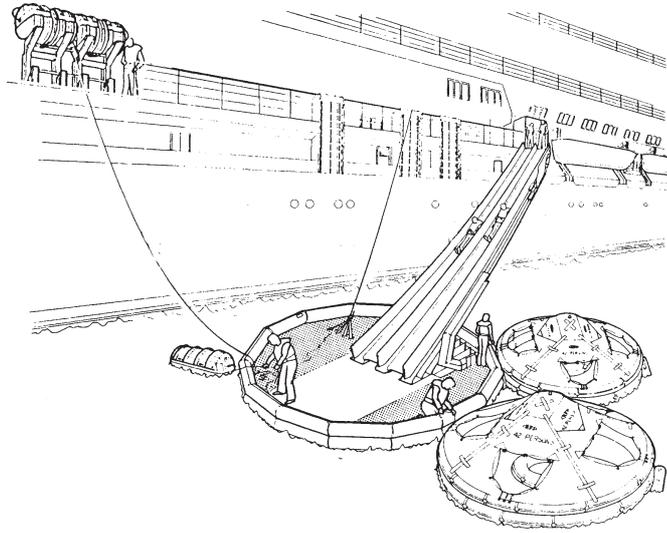


Figure 8.11 Marine excavation system.

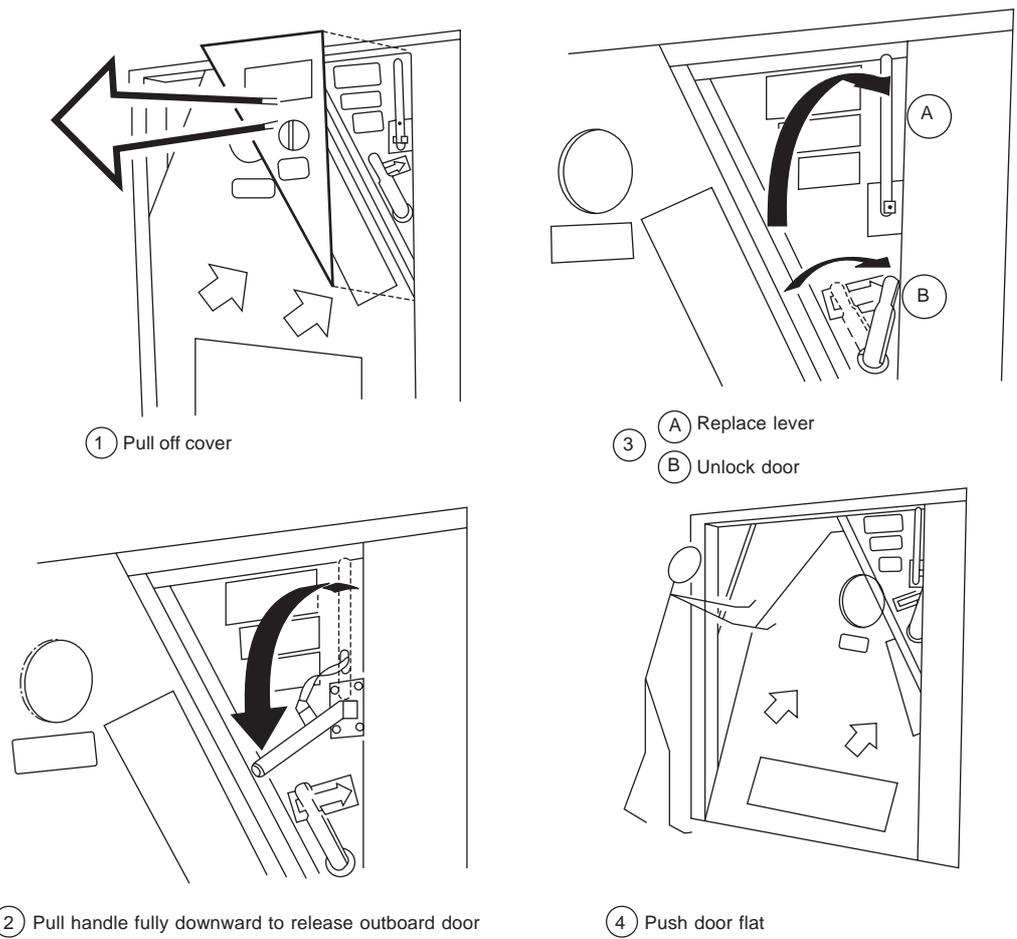


Figure 8.12 Operation of Marine escape system.

variable depending on the passenger carrying capacity of the vessel using the system.

RIGHTING CAPSIZED LIFE RAFT

In the event of the life raft inflating in a capsized condition the mariner's priorities are to turn it the right way up and stream the sea anchor (drogue) as soon as practical to prevent sea conditions causing another capsize. The procedure for one man is first to turn the raft into the wind and then climb over the gas bottle on to the base of the raft (Figure 8.13). It will be seen that a righting strap passes directly under the base of the raft and runs across the full diameter. The mariner should take hold of the righting strap and endeavour to climb up over the base of the raft. Once he has gained enough height, he should lean backwards, dragging the raft over by the strap virtually on top of himself, in the water. If the raft has been turned into the wind, then the wind will assist the motion of righting the raft, acting on the area of the raft as on a sail.

Should the raft initially inflate in this manner, it can normally be expected to lie on its side like a capsized cone, since the weight of the gas bottle causes the balance of the raft to be offset, and the heavy side of the raft to lie well down in the water. For this reason it is essential that the mariner attempts to right the raft from the low side, pushing the heavy gas bottle with his feet under the base of the raft as righting occurs.

Once the raft has been righted, the mariner may find that he is underneath it. At this stage there is no need for panic, because a saucer shape containing air is formed between the raft base and the sea surface, which will allow the individual to breathe for some considerable time. However, once the raft has been righted, the seafarer should endeavour to come out from under the raft, hand for hand, against the base of the raft. He should leave the righted raft from the opposite end to where the bottle is lying in the water.

Once clear, the mariner should then board and commence normal survival techniques, bearing in mind that he is not a survivor until rescued.

BEACHING A LIFE RAFT

If it becomes necessary to beach a raft, the operation should preferably be carried out during the hours of daylight on a sandy beach having a gradual slope. Circumstances will dictate the conditions, however, and the mariner should base his tactics on the weather and the proposed beaching area.

Preparations to beach the raft should be made well outside the line of surf and should include the inflating of the double floor, the donning of lifejackets by all persons, the opening of entrances and the manning of paddles, and the streaming of one or two sea anchors.

The raft should be allowed to drift into the line of surf, while the weight on the sea anchors is checked. A sharp lookout should be kept

NB. A similar principle is now used in a vertical 'chute' which allows a zig-zag movement of personnel into covered rafts at the surface. Known as Marine Evacuation Chutes (MEC)

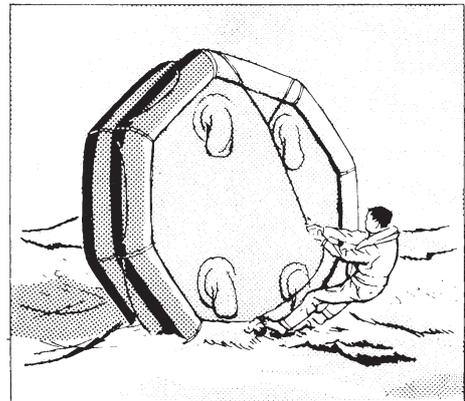


Figure 8.13 Righting life raft.

for rocks and similar obstructions and the raft fended off from the dangerous. On striking the shoreline, two men should endeavour to pull the raft ashore as far up the beach as possible. Other survivors should disembark as quickly as they can, then salvage equipment and the raft itself.

It should be borne in mind that the survival craft contains all the necessary life support systems. The raft itself will provide shelter in its inflated condition even on dry land. The gas bottle could be removed from the underside in order to allow the raft to lie flat, but the survival craft should not be deflated until a rescue is evident. The bright colour of the canopy will attract the rescue services, and to this end the survival craft should not be pulled up under cover of trees or cliff overhangs.

Stowage of Life Rafts (Cargo Ships)

Every life raft, other than those required by Regulation 26.1.4, shall be stowed with its painter permanently attached to the ship and with a float free arrangement which complies with the regulations. The arrangement should allow the life raft to float free and in the case of an inflatable raft, it should inflate automatically.

In the case of passenger ships the stowage shall be as far as practical the same as for cargo ships.

Regulation 26.1.4

Cargo ships where the survival craft are stowed in a position which is more than 100 m from the stem or stern shall carry, in addition to the life rafts required by paragraphs 1.1.2 and 1.2.2 (of this regulation) a life raft stowed as far forward or aft, or one as far forward and another as far aft, as is reasonable and practicable. Notwithstanding the requirements of Regulation 29, such life raft or life rafts may be securely fastened as to permit manual release and need not be of a type which can be launched from an approved launching device. (The above references are taken from the 1984 amendments to the SOLAS convention 1974.)

Containers for Inflatable Life Rafts

Containers for life rafts shall be constructed to withstand hard wear under conditions encountered at sea. They should have inherent buoyancy when packed with the life raft and its equipment, to pull the painter from within and to operate the inflation mechanism should the ship sink. Containers should be watertight, except for drain holes in the container bottom.

Servicing of Life Rafts

Every inflatable life raft shall be serviced:

- (a) at intervals of not exceeding 12 months. However, in cases where it appears proper and reasonable, the Authority may extend this period to 17 months.

- (b) servicing should take place at an approved service station, which maintains proper service facilities and only properly trained personnel.

Lifejacket Requirements

Passenger Ships

A lifejacket shall be provided for every person on board the ship and in addition:

- (a) a number of lifejackets suitable for children equal to at least 10 per cent of the number of passengers on board shall be provided or such greater number as may be required to provide a lifejacket for each child.
- (b) a sufficient number of lifejackets shall be carried for persons on watch and for use at remotely located survival craft stations.
- (c) every passenger ship shall carry additional lifejackets, for not less than 5 per cent of the total number of persons on board. These lifejackets being stowed in conspicuous places on deck or at muster stations.
- (d) as from 1 July, 1991, every lifejacket carried on a passenger ship which is engaged on international voyages, shall be fitted with a light which complies with the regulations.

Cargo Ships

A lifejacket shall be provided for every person on board the ship. Each lifejacket will be fitted with a light which complies with the regulations (applicable from 1 July, 1991).

Lifejackets shall be so placed on every vessel, as to be readily accessible and their position shall be plainly indicated. Where, due to the particular arrangements of the ship, the individual lifejackets may become inaccessible, alternative provisions shall be made to the satisfaction of the authority. This may include an increase in the number of lifejackets to be carried.

Every lifejacket should comply with the regulation specifications and may be of the automatic inflated type.

They should be constructed to the general requirements and fitted with retro-reflective material, be rot-proof and corrosive-resistant and should not be unduly affected by seawater, sunlight, oil or fungal attack. They should be capable of satisfactory operation and be manufactured in a highly visible colour.

General Requirements for Lifejackets

1. A lifejacket shall not sustain burning or continue melting after being totally enveloped in fire for a period of 2 seconds.
2. A lifejacket shall be so constructed that:
 - (a) after demonstration, a person can correctly don it within a period of 1 minute without assistance.

- (b) it is capable of being worn inside out, or is clearly capable of being worn in only one way and, as far as possible, cannot be donned incorrectly.
 - (c) it is comfortable to wear.
 - (d) it allows the wearer to jump from a height of at least 4.5 m into the water without injury and without dislodging or damaging the lifejacket.
3. A lifejacket shall have sufficient buoyancy and stability in calm and fresh water to:
- (a) Lift the mouth of an exhausted or unconscious person not less than 120 mm clear of the water with the body inclined backwards at an angle of not less than 20° and not more than 50° from the vertical position.
 - (b) Turn the body of an unconscious person in the water from any position to one where the mouth is clear of the water in not more than 5 seconds.
4. A lifejacket shall have buoyancy which is not reduced by more than 5 per cent after 24 hours submersion in fresh water.
5. A lifejacket shall allow the person wearing it to swim a short distance and to board a survival craft.
6. Each lifejacket shall be fitted with a whistle securely fastened by a cord.

Lifejacket Lights

Each lifejacket light shall:

- (a) Have a luminous intensity of not less than 0.75 cd. (*Practical range 1.0 nautical mile.*)
- (b) Have a source of energy capable of providing a luminous intensity of 0.75 cd for a period of at least 8 hours.
- (c) Be visible over as great a segment of the upper hemisphere as is practicable when attached to a lifejacket.

If the light of the lifejacket is a flashing light it shall in addition:

be provided with a manually operated switch;
not be fitted with a lens or reflector to concentrate the beam; and
flash at a rate of not less than 50 flashes per minute with a luminous intensity of at least 0.75 cd.

Inflatable Lifejackets

A lifejacket which depends on inflation for buoyancy shall have not less than two separate compartments and comply with the regulations for fixed buoyancy type lifejackets.

They should:

- (a) inflate automatically on immersion, be provided with a device to permit inflation by a single manual motion, and be capable of being inflated by the mouth;

- (b) in the event of loss of buoyancy, in any one compartment, the lifejacket should still be capable of maintaining the standards set by the regulations for standard lifejackets.

General Requirements and Specifications for Lifebuoys

Passenger and Cargo Ships

Lifebuoys should be so distributed so that they are readily available on both sides of the ship and as far as practicable on all open decks extending to the ship's sides. At least one should be placed in the vicinity of the stern.

They should be stowed so that they are capable of being cast loose and not permanently secured in any way. At least one lifebuoy on each side of the vessel should be fitted with a buoyant line, equal in length to not less than twice the height at which it is stowed above the waterline in the lightest seagoing condition, or 30 m, whichever is the greater.

Not less than one-half of the total number of lifebuoys should be provided with self-igniting lights and not less than two of these should also be provided with self-activating smoke signals and capable of quick release from the navigation bridge. These lifebuoys should be equally distributed on either side of the ship and should not be the lifebuoys previously stated with buoyant lines.

Each lifebuoy shall be marked in block capitals of the Roman alphabet with the name and port of registry of the ship on which it is carried.

See page 153 Part II for Man overboard Bridge Wing lifebuoy.

Passenger Ship's minimum number of lifebuoys

<i>Length of ship (m)</i>	<i>Minimum number of Lifebuoys</i>
Under 60	8
60 and under 120	12
120 and under 180	18
180 and under 240	24
240 and over	30

(Passenger ships of under 60 m in length shall carry not less than 6 lifebuoys provided with self igniting lights.)

Cargo Ship's minimum number of lifebuoys

<i>Length of ship (m)</i>	<i>Minimum number of lifebuoys</i>
Under 100	8
100 and under 150	10
150 and under 200	12
200 and over	14

Specifications

Every lifebuoy shall:

1. have an outer diameter of not less than 800 mm and an inner diameter of not less than 400 mm;

2. be constructed of inherently buoyant material; it shall not depend on rushes, cork shavings or granulated cork, any other loose granulated material or any air compartment which depends on inflation for buoyancy;
3. be capable of supporting not less than 14.5 kg of iron in fresh water for a period of 24 hours;
4. have a mass of not less than 2.5 kg;
5. not sustain burning or melting after being totally enveloped in a fire for a period of 2 seconds;
6. be constructed to withstand a drop into the water from a height at which it is stowed above the waterline in the lightest seagoing condition or 30 m whichever is the greater without impairing either its operating capability or that of its attached components;
7. if it is intended to operate the quick release arrangement provided for the self-activated smoke signals and self-igniting lights, have a mass sufficient to operate the quick release arrangement or 4 kg, whichever is the greater;
8. be fitted with a grabline not less than 9.5 mm in diameter and not less than 4 times the outside diameter of the body of the buoy in length. The grabline shall be secured at four equidistant points around the circumference of the buoy to form four equal loops.

*Lifebuoy Self-Igniting Lights**

As required by the regulations, self-igniting lifebuoy lights shall:

- (a) be such that they cannot be extinguished by water;
- (b) be capable of burning continuously with a luminous intensity of not less than 2 cd in all directions of the upper hemisphere or flashing at a rate of not less than 50 flashes per minute with at least the corresponding effective luminous intensity;
- (c) be provided with a source of energy capable of meeting the stated requirements for a period of at least 2 hours;
- (d) be capable of withstanding the drop test into water from the stowed position or from 30 m, whichever is the greater.

Lifebuoy Self-Activating Smoke Signals

As required by the regulations, self-activating smoke signals shall:

- (a) emit smoke of a highly visible colour at a uniform rate for a period of at least 15 minutes when floating in calm water;
- (b) not ignite explosively or emit any flame during the entire smoke emission of the signal;
- (c) not be swamped in a seaway;
- (d) continue to emit smoke when fully submerged in water for a period of at least 10 seconds;

*Self-igniting lights on lifebuoys of tankers shall be of an electric battery type.

- (e) be capable of withstanding the drop test into the water from the stowed position or from 30 m, whichever is the greater.

Buoyant Lifelines (attached to lifebuoys)

The buoyant lifelines attached to lifebuoys should be of a nature and structure which is non-kinking and have a diameter of not less than 8 mm, with a breaking strength of not less than 5 kN.

Immersion Suits

With respect to passenger ships constructed before 1 July 1986 the requirements shall not apply until 1 July 1991.

Passenger ships shall carry for each lifeboat on the ship at least three immersion suits which comply with the regulations. In addition a thermal protective aid must be provided for every other person who is to be accommodated in the lifeboat, who is not provided with an immersion suit.

These immersion suits and thermal protective aids need not be carried if:

- (a) persons are to be accommodated in totally or partially enclosed lifeboats.
- or
- (b) if the ship is constantly engaged on voyages in warm climates where in the opinion of the authority, thermal protective aids are unnecessary.

With respect to the rescue boat of passenger and cargo ships, each person assigned to the crew of a rescue boat will be provided with an immersion suit of appropriate size, which complies with the regulations.

Cargo ships shall carry for each lifeboat on the ship at least three immersion suits which comply with the regulations, or, if the Authority considers it necessary and practicable, one immersion suit for every person on board the ship.

However, in addition to immersion suits required for life rafts, lifeboats and rescue boats the vessel shall carry thermal protective aids for persons not provided with immersion suits.

These immersion suits and thermal protective aids need not be required if the ship:

- (a) has totally enclosed boats on each side of the ship of such aggregate capacity as will accommodate the total number of persons aboard;
or
- (b) has totally enclosed lifeboats capable of being launched by free fall over the stern of the ship of such aggregate capacity as will accommodate the total number of persons on board, launched directly from the stowed position, together with life rafts on each side of the ship of such aggregate capacity as will accommodate the total number of persons aboard; or
- (c) is constantly engaged on voyages in warm climates where in the opinion of the Authority immersion suits are unnecessary.

Cargo ships of less than 85 m length other than oil tankers, chemical tankers and gas carriers, shall carry immersion suits which comply with the regulations for every person on board unless the ship:

- (a) has davit launched life rafts; or
- (b) has life rafts served by equivalent approved appliances, capable of being used on both sides of the ship and which do not require entry into the water to board the life raft; or
- (c) is constantly engaged on voyages in warm climates where in the opinion of the Authority immersion suits are unnecessary.

The immersion suits required to be carried by cargo vessels may be used to comply with the requirements for rescue boats.

Life rafts shall be provided with thermal protective aids which comply with the regulations, sufficient for 10 per cent of the number of persons the raft is permitted to carry or two whichever is greater.

Lifeboats shall be provided with thermal protective aids which comply with the regulations, sufficient for 10 per cent of the number of persons the lifeboat is permitted to accommodate or two, whichever is the greater.

General Requirements for Immersion Suits

1. The immersion suit shall be constructed with waterproof material so that:
 - (a) it can be unpacked and donned without assistance within 2 minutes taking into account any associated clothing and a lifejacket if the immersion suit is to be worn in conjunction with a lifejacket;
 - (b) it will not sustain burning or continue melting after being totally enveloped in a fire for a 2 second period;
 - (c) it will cover the whole body with the exception of the face. Hands shall also be covered unless permanently attached gloves are provided;
 - (d) it is provided with arrangements to minimise or reduce free air in the legs of the suit;
 - (e) following a jump from a height of not less than 4.5 m into the water there is no ingress of water.
2. An immersion suit, which complies with regulations concerning lifejackets, may be classified as a lifejacket.
3. An immersion suit shall permit the person wearing it, and also wearing a lifejacket, if the suit is to be worn in conjunction with a lifejacket to:
 - (a) climb down a vertical ladder at least 5 m in length;
 - (b) perform normal duties during abandonment;
 - (c) jump from a height of not less than 4.5 m into the water without damaging or dislodging the immersion suit or being injured;



35. Training with helicopter strop. Use of immersion suit, and lifejacket requirement.

- (d) swim a short distance through the water and board a survival craft.
4. An immersion suit which has buoyancy and which is designed to be worn without a lifejacket shall be fitted with a light and whistle that comply with the lifejacket regulations.
 5. If the immersion suit is designed to be worn in conjunction with a lifejacket, the lifejacket should be worn over the immersion suit. The person wearing such an immersion suit shall be able to don a lifejacket.

Performance Requirements

An immersion suit made of material which has no inherent insulation shall be:

- (a) marked with instructions that it must be worn in conjunction with warm clothing;
- (b) so constructed that when worn in conjunction with warm clothing and a lifejacket, if the suit is to be worn with a lifejacket, it shall continue to provide sufficient thermal protection following one jump, by the wearer into the water from a height of 4.5 m to ensure that when it is worn for a period of 1 hour in calm circulating water at a temperature of 5°C, the wearer's body core temperature does not fall more than 2°C.

An immersion suit made of material with inherent insulation, when worn either on its own or with a lifejacket, if the suit is to be worn with a lifejacket, shall provide the wearer with sufficient thermal insulation following one jump into the water from a height of 4.5 m to ensure that the wearer's body core temperature does not fall more than 2°C after a period of 6 hours in calm circulating water at a temperature of between 0° and 2°C.

The immersion suit shall permit the person wearing it, with hands covered to pick up a pencil and write after being immersed in water at 5°C for a period of 1 hour.

Buoyancy Requirements of Immersion Suits

A person in fresh water wearing either an immersion suit complying with the lifejacket regulations, or an immersion suit with a separate lifejacket, shall be able to turn from face down to a face up position in not more than 5 seconds.

Thermal Protective Aids (Not to be confused with Immersion Suits)

1. A thermal protective aid shall be made of waterproof material having a thermal conductivity of not more than 0.25 W/(m.K) and shall be so constructed that, when used to enclose a person, it shall reduce both the convective and evaporative heat loss from the wearer's body.
2. The thermal protective aid shall:
 - (a) cover the whole body of a person wearing a lifejacket with the exception of the face. Hands shall also be covered unless permanently attached gloves are provided.
 - (b) be capable of being unpacked and easily donned without assistance in a survival craft or rescue boat.
 - (c) permit the wearer to remove it in the water in not more than 2 minutes if it impairs ability to swim.
3. The thermal protective aid shall function properly throughout an air temperature range -30°C to +20°C.

Rescue Boats

A rescue boat is defined as a boat designed to rescue persons in distress and to marshal survival craft.

The 1983 amendments to the SOLAS convention of 1974 requires:

Passenger ships of 500 tonnes gross and over shall carry at least one rescue boat which complies with the regulations, on either side of the ship.

Passenger ships of less than 500 tonnes gross shall carry at least one rescue boat which complies with the regulations.

Cargo ships shall carry at least one rescue boat which complies with the regulations. A lifeboat may be accepted as a rescue boat, provided that it complies with the requirements for rescue boats.

If the rescue boat carried is a lifeboat it may be included in the aggregate capacity, for cargo ships less than 85 m in length. This is provided that the life raft capacity on either side of the vessel is at least 150 per cent of the total number of persons on board.

Similarly for passenger ships of less than 500 tonnes gross, and where the total number of persons on board is less than 200, if the rescue boat is also a lifeboat, then it may be included in the aggregate capacity. This is provided that the life raft capacity on either side of the ship is at least 150 per cent of the total number of persons on board.

The regulations state that:

The number of lifeboats and rescue boats that are carried on passenger ships shall be sufficient to ensure that in providing for abandonment by the total number of persons on board not more than six life rafts need be marshalled by each lifeboat or rescue boat.

The number of lifeboats and rescue boats that are carried on passenger ships engaged on short international voyages and complying with the special standards of subdivision prescribed by Regulation II-1/6.5 shall be sufficient to ensure that in providing for abandonment by the total number of persons on board not more than nine life rafts need be marshalled by each lifeboat or rescue boat.

Launching Arrangements for Rescue Boats

Rescue boat arrangements shall be such that the rescue boat can be boarded and launched directly from the stowed position with the number of persons assigned to crew the rescue boat on board.

If the rescue boat is also a lifeboat, and other lifeboats can be boarded and launched from an embarkation deck, the arrangements shall be such that the rescue boat can also be boarded and launched from the embarkation deck.

Every rescue boat launching device shall be fitted with a power winch motor of such capacity that the rescue boat can be raised from the water with its full complement of persons and equipment. It should be kept at a continuous state of readiness for launching in not more than five minutes and be stowed in a suitable position to allow launch and recovery.

General Requirements for Rescue Boats

1. Rescue boats may be either of rigid or inflated construction or a combination of both.
2. Not less than 3.8 m and not more than 8.5 m in length. Capable of carrying at least five seated persons and a person lying down.
3. Rescue boats, which are a combination of rigid and inflated construction, shall comply with the appropriate requirements of the regulations affecting rescue boats to the satisfaction of the Authority.
4. Unless the rescue boat has adequate sheer, it shall be provided with a bow cover extending for not less than 15 per cent of its length.
5. Rescue boats shall be capable of manoeuvring at speeds up to 6 knots and maintaining that speed for a period of at least 4 hours.
6. Rescue boats shall have sufficient mobility and manoeuvrability in a seaway to enable persons to be retrieved from the water, marshal life rafts and tow the largest life raft carried on the ship with its full complement of persons and equipment or its equivalent at a speed of at least 2 knots.
7. A rescue boat shall be fitted with an inboard engine or outboard motor. If it is fitted with an outboard motor, the rudder and the tiller may form part of the engine. Notwithstanding the Regulation 41.6.1 (regarding flashpoint of fuel of 43° or less) outboard engines with an approved fuel system may be fitted in rescue boats provided the fuel tanks are specially protected against fire and explosion.
8. Arrangements for towing shall be permanently fitted in rescue boats and shall be sufficiently strong to marshal or tow life rafts as required in 6 above.
9. Rescue boats shall be fitted with weathertight stowage for small items of rescue equipment.

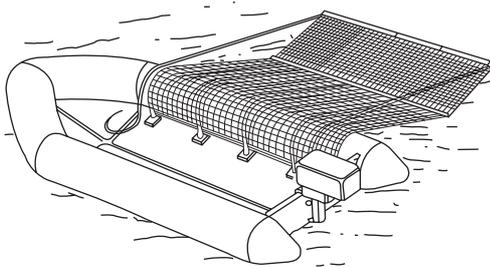


Figure 8.14 Recovery by rescue boat. Recovery methods should endeavour to bring casualties aboard over the weather bow by means of a 'House Recovery Net' or other horizontal method.

Rescue boats should be constructed in a manner to provide adequate stability and with inherent strength to withstand launching. Its internal capacity being established by similar means as with lifeboats. Access should be such as to permit rapid boarding by individuals and also allow persons to be retrieved from the sea or brought aboard on stretchers. Acceptable propulsion and steering arrangements together with a release launching mechanism must be approved by the Authority. A method of release of the forward painter and skates for launching down the ship's sides if necessary to prevent damage to the boat.

Rescue Boat Equipment

All items of rescue boat equipment, with the exception of boat hooks, which shall be kept free for fending off purposes, shall be secured within the rescue boat by lashings, storage in lockers or compartments, storage in brackets or similar mounting arrangements or other suitable means. The equipment shall be secured in such a manner as not to interfere with any launching or recovery procedures. All items of rescue boat equipment shall be small and of as little mass as possible and shall be packed in suitable and compact form.

1. Sufficient buoyant oars or paddles to make headway in calm seas. Thole pins, crutches or equivalent arrangements shall be provided for each oar. Thole pins or crutches shall be attached to the boat by lanyards or chains.
2. A buoyant bailer.
3. A binnacle containing an efficient compass which is luminous or provided with suitable means of illumination.
4. A sea anchor and tripping line with hawser of adequate strength, and not less than 10 m in length.
5. A painter of sufficient length and strength, attached to the release device complying with the regulations, to enable the forward painter to be released under tension.
6. One buoyant line, not less than 50 m in length, of sufficient strength to tow a life raft as required by the regulations.
7. One waterproof electric torch suitable for morse signalling, together with one spare set of batteries and one spare bulb in a waterproof container.
8. A whistle or equivalent sound signal.
9. A first aid outfit in a waterproof container capable of being closed tightly after use.
10. Two buoyant rescue quoits, attached to not less than 30 m of buoyant line.
11. A searchlight capable of effectively illuminating a light coloured object at night having a width of 18 m at a distance of 180 m for a total period of 6 hours and of working continuously for at least 3 hours.
12. An efficient radar reflector.
13. Thermal protective aids complying with the regulations and sufficient for 10 per cent of the number of persons the rescue boat is permitted to carry (a minimum of two).

Additional Equipment Requirements for Rescue Boats

Every rigid rescue boat shall include with its normal equipment:

- (a) a boat hook;
- (b) a bucket;
- (c) a knife or hatchet.

Every inflated rescue boat shall include with its normal equipment:

- (a) a buoyant safety knife;
- (b) 2 sponges;
- (c) an efficient manually operated bellows or pump;
- (d) a repair kit in a suitable container, for repairing punctures;
- (e) a safety boat hook.

Additional Requirements for Inflated Rescue Boats

The mariner should also be aware of the following general particulars which affect rescue boats of the inflated type. Unlike hulls and rigid



36. Semi-rigid inflatable

covers of lifeboats they do not have to be fire retardant but they should be of sufficient strength and rigidity to withstand launch and recovery in the inflated condition when slung from its bridle or lifting hook (with full complement). The strength should be such as to withstand four times the load of the total mass of persons and equipment and capable of withstanding exposure on an open deck of a ship at sea or 30 days afloat in all sea conditions.

They should be marked as for an ordinary lifeboat but carry in addition, a serial number, the maker's name or trade mark, and the date of manufacture. Underneath the bottom and on vulnerable places on the outside of the hull, in the inflated condition, rubbing strips shall also be provided to the satisfaction of the authority.

The buoyancy of inflated rescue boats shall be a single tube which is sub-divided into at least five separate compartments of approximate equal volume, or two separate tubes neither of which exceed 60 per cent of the total volume. The tubes should be so arranged that in the event of any one of the compartments becoming damaged, the intact compartments shall be capable of supporting the full complement. The buoyancy tubes when inflated, forming the boundary of the boat, shall provide a volume not less than 0.17 m^3 for each person the boat is permitted to carry. Each buoyancy compartment will be provided with a non-return valve for manual inflation and means should be provided for deflation. A safety relief valve will also be fitted if the Authority considers this a necessary requirement.

If a transom stern is fitted, it should not be inset by more than 20 per cent of the boat's length. Suitable patches shall be provided for securing painters fore and aft and securing of the becketed lifeline inside and outside the boat. The boat itself should be maintained at all times in the inflated condition.

Emergency Communications (Applicable Passenger and Cargo Ships)

General Emergency Alarm Signal

The general emergency alarm signal shall be capable of sounding the general alarm signal consisting of seven or more short blasts followed by one long blast on the ship's whistle or siren and additionally on an electrically operated bell or klaxon or other equivalent warning system, which shall be powered from the ship's mains supply and the emergency source of electrical power required by the regulations.

The system shall be capable of operation from the navigation bridge and, except for the ship's whistle, also from other strategic points. The system shall be audible throughout all accommodation and normal crew working spaces, and supplemented by a public address or other suitable communication system.

An emergency means comprising either fixed or portable equipment, or both, shall be provided for two-way communications between emergency control stations, muster and embarkation stations and strategic positions on board.

Two-Way Radiotelephone Apparatus

Two-way radiotelephone apparatus, which complies with the regulations shall be provided for communication between survival craft, between survival craft and the parent ship, and between the ship and rescue boat. An apparatus need not be provided for every survival craft however, at least three apparatus shall be provided on each ship. This requirement may be complied with by other apparatus used on board provided such apparatus is not incompatible and is appropriate for emergency operations.

Muster Lists

Clear instructions shall be provided for every person to follow in the event of an emergency. Muster lists which specify the requirements laid down by the regulations shall be exhibited in conspicuous places throughout the ship, including the navigation bridge, engine-room and crew accommodation spaces. Illustrations and instructions in the appropriate language shall be posted in passenger cabins and displayed at muster stations and passenger spaces to inform passengers of:

- (a) their muster station;
- (b) the essential actions they should take in an emergency;
- (c) the method of donning lifejackets.

Content of Muster Lists

The muster list shall specify detail of the general alarm signal and also the action to be taken by crew and passengers when the alarm is sounded. The list will specify how the order to abandon ship will be given.

The muster list shall show the duties assigned to different members of the crew including:

- (a) closing of watertight doors, fire doors, valves, scuppers, sidescuttles, skylights, portholes and other similar openings in the ship;
- (b) the equipping of survival craft and other life-saving appliances;
- (c) the preparation and launching of survival craft;
- (d) the general preparations of other life-saving appliances;
- (e) the muster of passengers;
- (f) the use of communication equipment;
- (g) manning of fire parties to deal with fires;
- (h) special duties assigned in respect of the use of fire fighting equipment and installations.

The muster list shall specify which officers are assigned to ensure that life-saving appliances and fire appliances are maintained in good condition and ready for immediate use. Muster lists should also specify substitutes for key persons who may become disabled, taking into account that different emergencies may call for different actions.

The muster list shall show the duties assigned to crew members in relation to passengers in case of emergency. These duties shall include:

1. warning the passengers;

2. seeing that they are suitably clad and have donned their lifejackets correctly;
3. assembling passengers at muster stations;
4. keeping order in passageways and on stairways and generally controlling the movements of passengers;
5. ensuring that a supply of blankets is taken to the survival craft.

The muster lists shall be prepared before the ship proceeds to sea and be of an approved type in the case of passenger ships.

On Board – Passenger Ship Drills and Training

Drills

An abandon ship drill and fire drill shall take place weekly.

Applicable to all vessels

Each member of the crew shall participate in at least one abandon ship drill and one fire drill every month. The drills of the crew shall take place within 24 hours of the ship leaving a port if more than 25 per cent of the crew have not participated in abandon ship and fire drills on board that particular ship in the previous month. The Authority may accept other arrangements that are at least equivalent for those classes of ship for which this is impracticable.

On a ship engaged on an international voyage, which is not a short international voyage, musters of the passengers shall take place within 24 hours after embarkation. Passengers should be instructed in the use of lifejackets and actions to take in the event of an emergency.

Content of Abandon Ship Drill

Each abandon ship drill shall include:

1. summoning passengers and crew to muster stations with the alarm required by the regulations and ensuring that they are made aware of the order to abandon ship specified in the muster list;
2. reporting to stations and preparing for the duties described in the muster list;
3. checking that passengers and crew are suitably dressed;
4. checking of lifejackets to ensure that they are correctly donned;
5. lowering of at least one lifeboat after any necessary preparation for launching;
6. starting and operating the lifeboat engine;
7. operation of davits used for launching life rafts.

The regulations specify that each lifeboat shall be launched with its assigned crew aboard and manoeuvred in the water at least once every three months, during an abandon ship drill. However, ships operating on short international voyages may be relieved of this obligation if their berthing arrangements do not permit the launching, but all such boats should be lowered at least once every three months and launched at least

annually. As far as practicable rescue boats, if not lifeboats, should be launched with their assigned crew at least each month and in any event launched at least once in three months.

Drills should be conducted as if there were an actual emergency and different boats used at successive drills. If drills are carried out with the ship making headway, because of the dangers involved, practice should take place in sheltered waters, under the supervision of an experienced officer.

The regulations now require that on board training in the use of the ship's life-saving appliances shall be given as soon as possible but not later than two weeks after a crew member joins the ship. Instruction in survival at sea should be given at the same intervals as drills, and coverage of all ship's life-saving equipment should be covered within a period of two months.

Instruction should include specifically:

- instruction in the use of inflatable life rafts;
- treatment and associated problems of hypothermia and first aid procedures;
- special instructions in the use of gear when in severe weather and sea conditions.

On board training in the use of davit launched life raft shall take place at intervals of not more than four months on every ship fitted with such appliances. Whenever practicable this shall include the inflation and lowering of a life raft. This life raft may be a special raft, intended for training purposes only, and if so it should be conspicuously marked as such.

Training Manual

A training manual will be provided for each crew messroom, recreation room or in each crew member's cabin. The contents of this manual shall include:

- (a) the donning of lifejackets and immersion suits as appropriate;
- (b) muster arrangements at the assigned stations;
- (c) a method of launching from within the survival craft;
- (d) the releasing method from the launching appliance;
- (e) methods and use of devices for protection in launching areas, where appropriate;
- (f) illumination in launching areas;
- (g) use of all survival equipment;
- (h) use of all detection equipment;
- (i) with the assistance of illustrations, the use of radio life-saving appliances;
- (j) use of drogues;
- (k) use of the engine and accessories;
- (l) recovery of survival craft and rescue boats including stowage and securing;

- (m) hazards of exposure and the need for warm clothing;
- (n) methods of retrieval, including the use of helicopter rescue gear (slings, baskets, stretchers), breeches buoy and shore life-saving apparatus and ship's line-throwing apparatus;
- (o) all other functions contained in the muster list and emergency instructions;
- (p) instructions for emergency repair of the life-saving appliances.

The manual, which may comprise several volumes, shall contain the information in an easily understood form, illustrated as appropriate, and may be provided as an audio-visual aid in lieu of a book format.

Manning Requirements for Survival Craft (applicable to all ships)

The regulations specify that there shall be a sufficient trained number of persons on board a ship for the mustering and assisting of untrained persons. A sufficient number of crew members, who may be deck officers or certificated persons on board for the operation of survival craft and their respective launching arrangements required for an abandonment by the total number of persons on board.

A deck officer or certificated person shall be placed in charge of each survival craft. However, the Authority having due regard to the nature of the voyage and the characteristics of the ship may permit persons practised in the handling and operation of life rafts to be placed in charge of life rafts instead of the persons qualified as above.

The Master shall ensure that persons qualified to carry out respective duties regarding the boatwork operations shall be allocated among all the ship's survival craft. Every motorised boat shall have a person assigned to it, who can operate the engine and carry out minor adjustments. Every lifeboat, which carries a radio telegraph installation, shall also have a person assigned to it who is capable of operating the equipment.

The person in charge of a survival craft shall have a list of the survival craft crew and ensure that they are familiar with their duties. The second in command of the lifeboats will also have a similar list.

COMMUNICATIONS



METHODS EMPLOYED IN MARINE INDUSTRY

Communications

Increased technology has caused communications to mushroom around the globe and nowhere more so has this occurred than in the maritime environment. Wireless telegraphy has been dispatched to the archives and since February 1999 the Global Maritime Distress and Safety System (GMDSS) has become compulsory for all passenger ships and cargo ships over 300 GT.

The system has been developed by the IMO and has formed part of the amendments to SOLAS.

Requirements for the Carriage of Equipment

In order to comply with the regulations ships will require specific items of equipment for operation in designated areas:

Sea area A1: ships will carry VHF equipment and either a satellite EPIRB, or a VHF EPIRB.

Sea area A2: ships will carry VHF and MF equipment and a satellite EPIRB.

Sea area A3: ships will carry VHF, MF, a satellite EPIRB and either HF or satellite communication equipment.

Sea area A4: ships will carry VHF, MF and HF equipment and a satellite EPIRB.

Additionally, all ships will also be equipped to receive Marine Safety Information (MSI) broadcasts and have continuous scanning ability of all HF safety frequencies with automatic printing ability of MSI messages. A Navtex receiver will also be on board to continuously monitor 518 kHz with programming capability to be selective of message category.

Ships will also be required to have a 'Radar Transponder' (SART) and two way radios for designated use with survival craft (minimum 3 W/Ts so designated for survival craft use only).

The vessel must also have at least one radar set capable of operating in the 9 GHz band.

Terminals to provide the above requirements are available.

Inmarsat A This offers the use of voice, data, facsimile and telex based communications.

Inmarsat C This is a smaller unit and offers text and data messaging at reduced speed.

Both terminals provide world coverage with the exception of the extreme polar regions.

Sea Area Definition

Sea Area A1 – An area within the radio telephone coverage of at least one VHF coast station in which continuous Digital Selective Calling (DSC) alerting is available, as may be defined by a Contracting Government. (The UK Government has not defined a sea area A1 so all vessels departing UK are immediately into Sea Area A2.)

Sea Area A2 – An area excluding A1 within the radiotelephone coverage of at least one coast station providing continuous watch on 2182 kHz and continuous DSC alerting on 2187.5 kHz as may be defined by a Contracting Government. (The UK has provided six Coast Guard stations with continuous DSC alerting capability which extends Sea Area A2 approximately 150 nm from the UK coastline.)

Sea Area A3 – An area excluding A1 and A2 within the coverage of an INMARSAT geostationary satellite by which continuous distress alerting is available.

(This is effectively everywhere between latitudes 70°N and 70°S.)

Sea Area A4 – An area outside Sea Areas A1, A2, and A3. (Namely the polar regions.)

EPIRBs

It is an IMO requirement that all vessels GMDSS compliant will carry a float free EPIRB. This is usually mounted in a bracket and fitted with a hydrostatic release unit (HRU) to enable float free capability in the event that the vessel sinks. The HRU has limited endurance and must be serviced or replaced periodically as per type/manufacturer's recommendations. HRUs are activated at a depth of 1.5 to 4.0 metres depth.

Similarly the battery of the EPIRB although it has a shelf life of six years (although it is normally changed after two years), its output capability must be sufficient to provide transmission power for a 48 hour continuous operating period. EPIRBs must also be tested on a monthly basis as per manufacturer's instructions. The SARSAT/COSPAS polar orbiting satellites receive transmitted EPIRB signals on 406 MHz. INMARSAT satellites receive transmitted EPIRB signals on 1.6 GHz. 406 MHz EPIRBs are fitted with a strobe light to aid visual location and also contain a homing signal operating on 121.5 MHz or may operate on 243 MHz.

Operation of the 406

Once a signal is received on board the satellite, Doppler shift measurements are taken and time coded. This is then processed as digital data and added to the digital message transmitted from the beacon. The whole is then stored on board the satellite for future transmission and also transmitted immediately in real time to any current Land User Terminal (LUT) within view from the space craft.

One of the main differences between the operation of the alternative frequencies is that transmissions from 406 beacons are acted on immediately, whereas transmissions on 121.5 are not acted upon until two transmissions have been received. It should also be noted that Doppler shift measurement is more accurate and 406 beacons can be located to within approximately three miles. In comparison, the location accuracy on 121.5 is about 12 miles. The other main difference between the two is that the 406 MHz EPIRB transmits an identification code, and the 121.5 homing beacon does not.

EPIRB function and purpose

The primary function of the EPIRB is to aid location of survivors in a distress situation. The signal transmitted is meant to indicate that a person or persons who may have been separated from their parent vessel and consequently may not have radio capability are in distress and require immediate assistance. Clearly an EPIRB aboard a distressed vessel could equally be used as a secondary means of transmitting a distress alert signal.

SARTs

The SART is a search and rescue radar transponder. It is portable and can be operated from the parent vessel or from a survival craft. Once operated the SART is intended to indicate its position to search units of either the surface vessel or aircraft type.

Operation of the SART is on (9 GHz) and can be interrogated by units operating 3 cm radar. Specification of the SART is such that it is identifiable at 5 nm from operation at 1 metre above surface. In comparison an aircraft could detect at about 40 miles because of its increased height.

SARTs are activated by the radar energy of an approaching search unit and starts its own transmission. The radar signature produced is a radial line of 12 dots over an approximate eight mile length on the search vehicles radar, from a position just beyond the position of the distress. As the search unit closes the target to about 1 nm, the dots become small arcs. The signature will change again to concentric circles when the range closes to a few hundred metres.

For best results, search Radar Operators should:

- (a) Turn off the anti-rain control
- (b) Place gain control to maximum
- (c) Operate on 6 nm range or less

- (d) Reduce clutter by down tuning slightly
- (e) Reduce range and gain control when closing target.

NB. SARTs are not designed to operate with 10 cm radar.

International Code of Signal Flags

This is a method of communication over short range, being limited by the need for transmitting and receiving stations to be in sight of each other. All British ships are obliged to carry a full set of international code flags, together with a copy of the code book, *International Code of Signals*. The flags cover the alphabet from A to Z, plus three substitutes, and the numerals from 0 to 9; and there is a code and answering pendant.

The system is extremely useful for communication if radio silence has to be maintained, as when a country is engaged in hostilities. The method proved ideal for signal transmission between ships in convoy and has shown itself to be a speedy communications system when employing single or even double flag hoists. Where code groups are used, it is time-consuming in transmission and in decoding the messages received.

During peaceful trading, single letter hoists tend to play a major part in harbour or port control with regard to the pilot service, port health clearance, fishing boats, emergency signals and the like. It is a requirement of all deck officers taking a watch to be alert for the use of single letter and important double letter flag hoists.

Morse Code by Flashing Light

This is a very fast method of communication when transmitted by an experienced operator. It may be carried out by Aldis lamp, direct to the receiving station, or by an all round lamp, either method being limited in range to the visual distance between transmitting and receiving stations. This method of communication is used between ship to shore as well as ship to ship. Normal speed of transmission is four to six words per minute.

The Aldis lamp should be kept readily available for emergency use if required. It is normally provided with sun shades, usually red and green, to allow operation during the hours of daylight.

Morse Code by Wireless Telegraphy (W/T)

With the full implementation of GMDSS from February 1999, Radio Officers and the use of W/T are virtually no longer used within the maritime communications field. Full world satellite coverage is now possible and all vessels over 300 GT are equipped to operate under the GMDSS regulations. It is a requirement of GMDSS compliance that a vessel must carry at least two qualified certificated personnel capable of operating the communication equipment.

NB. In the event of the vessel being requisitioned for a Search and Rescue operation, a designated communications operator must be identified within the bridge team.

Morse Code by Flag

This is a very slow and tiring method of communication. Transmission should be carried out slowly unless a person is very experienced in this style of signalling. Limited in range, it has the advantage that an injured party with only one arm available can use it.

Semaphore

This method employs two hand flags, which are positioned to indicate letters of the alphabet. It is limited in range to the visual distance between the transmitting and receiving stations. A good operator can transmit fifteen to eighteen words per minute. However, semaphore has been made obsolete in both the Royal Navy and the British mercantile marine, and it is no longer a requirement for deck officers to have detailed knowledge of it in order to qualify for a certificate of competency.

Very High Frequency (VHF)

Without doubt this is the most popular method of communication employed to date. It is limited in range with normal equipment to under 100 miles, though this distance will vary with weather and atmospheric conditions. It is a direct method of voice communication, which can be linked to land-based local telephone exchange systems or used between ships direct.

Miscellaneous Communications

Signals of distress are dealt with in Part 2, Chapter 5. Small boat landing signals are covered in Part 1, Chapters 7 and 8 and signals used in conjunction with the operation of the breeches buoy may be found in Part 2, Chapter 8.

FLAG SIGNALLING TERMS

At the Dip

This is the term used to describe a signal which is hoisted to approximately half the extent of the halyard.

Close Up

This term denotes that the flag hoist is flying at its maximum height, e.g. close up to the truck, at the mainmast.

Signal Letters

These are letters allocated to the vessels to signify the 'call sign' of that vessel, for the purpose of communication and identification.

Tackline

A length of halyard about 1 fathom in length, the tackline is used to separate two distinctive hoists on the same halyard.

SINGLE LETTER MEANINGS – INTERNATIONAL CODE OF SIGNALS

- A I have a diver down; keep well clear at slow speed.
- B I am taking in, or discharging, or carrying dangerous goods.
- C Yes (affirmative or 'The significance of the previous group should be read in the affirmative').
- D Keep clear of me; I am manoeuvring with difficulty.
- E I am altering my course to starboard.
- F I am disabled; communicate with me.
- G I require a pilot. When made by fishing vessels operating in close proximity on the fishing grounds it means: 'I am hauling nets'.
- H I have a pilot on board.
- I I am altering my course to port.
- J I am on fire and have dangerous cargo on board: keep well clear of me.
- K I wish to communicate with you.
- L You should stop your vessel instantly.
- M My vessel is stopped and making no way through the water.
- N No (negative or 'The significance of the previous group should be read in the negative'). This signal may be given only visually or by sound. For voice or radio transmission the signal should be 'No'.
- O Man overboard.
- P **In harbour.** All persons should report on board as the vessel is about to proceed to sea.
At sea. It may be used by fishing vessels to mean: 'My nets have come fast upon an obstruction'.
- Q My vessel is 'healthy' and I request free pratique.
- S I am operating astern propulsion.
- T Keep clear of me; I am engaged in pair trawling.
- U You are running into danger.
- V I require assistance.
- W I require medical assistance.
- X Stop carrying out your intentions and watch for my signals.
- Y I am dragging my anchor.
- Z I require a tug. When made by fishing vessels operating in close proximity on the fishing grounds it means: 'I am shooting nets'.

SIGNALLING BY INTERNATIONAL CODE FLAGS

How to Call

When calling a vessel which is known and identified, the transmitting station should hoist the signal letters of the vessel with which it wishes to communicate.

When the identity of the vessel called is not known, then a general signal of:

VF = 'You should hoist your identity signal', or
CS = 'What is the name or identity signal of your vessel'

should be made.

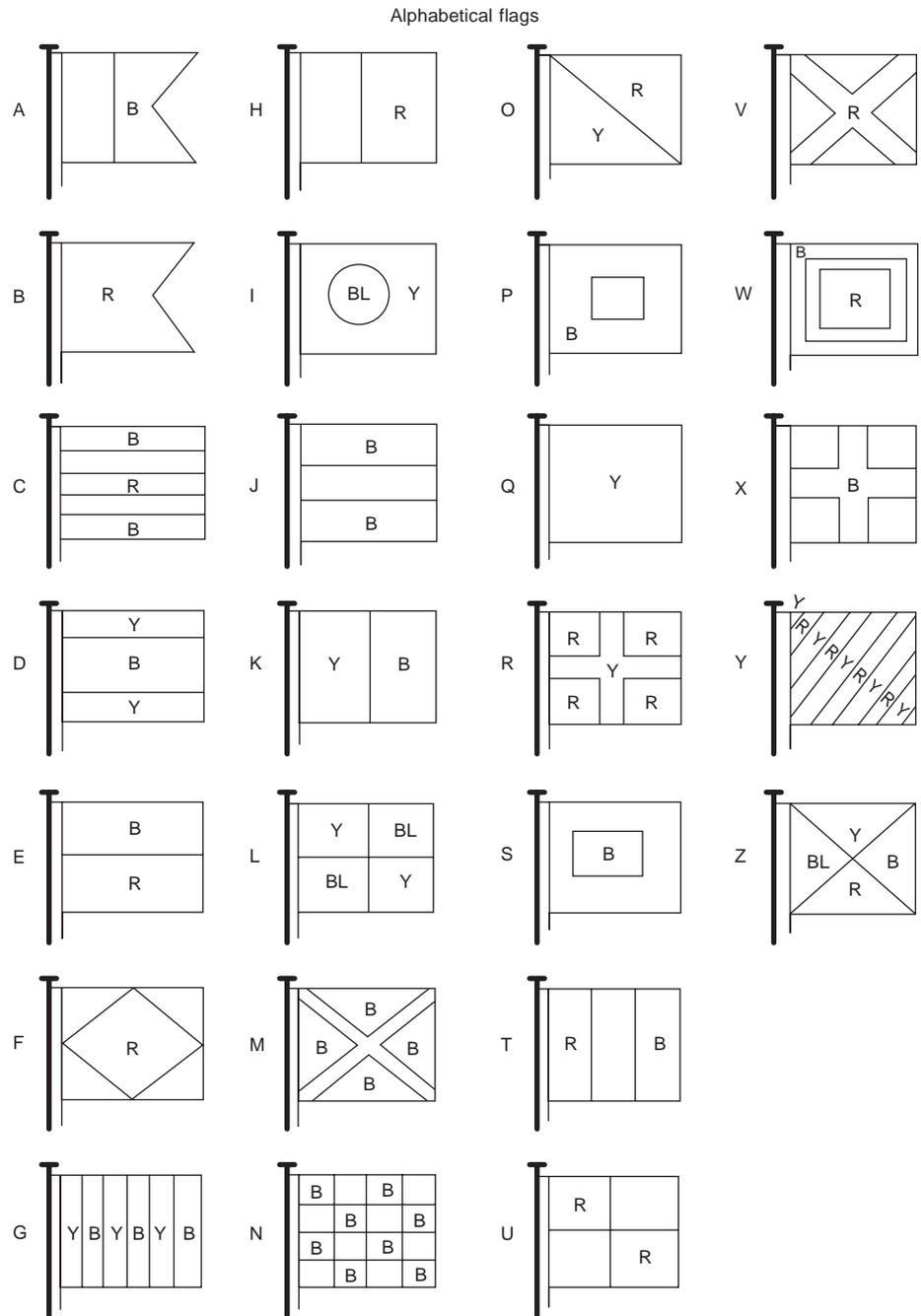


Figure 9.1 Flag at masthead.

Key: B = Blue; R = Red; Y = Yellow;
BL = Black.

Marine students are advised to colour the flags to assist learning and aid future recognition.

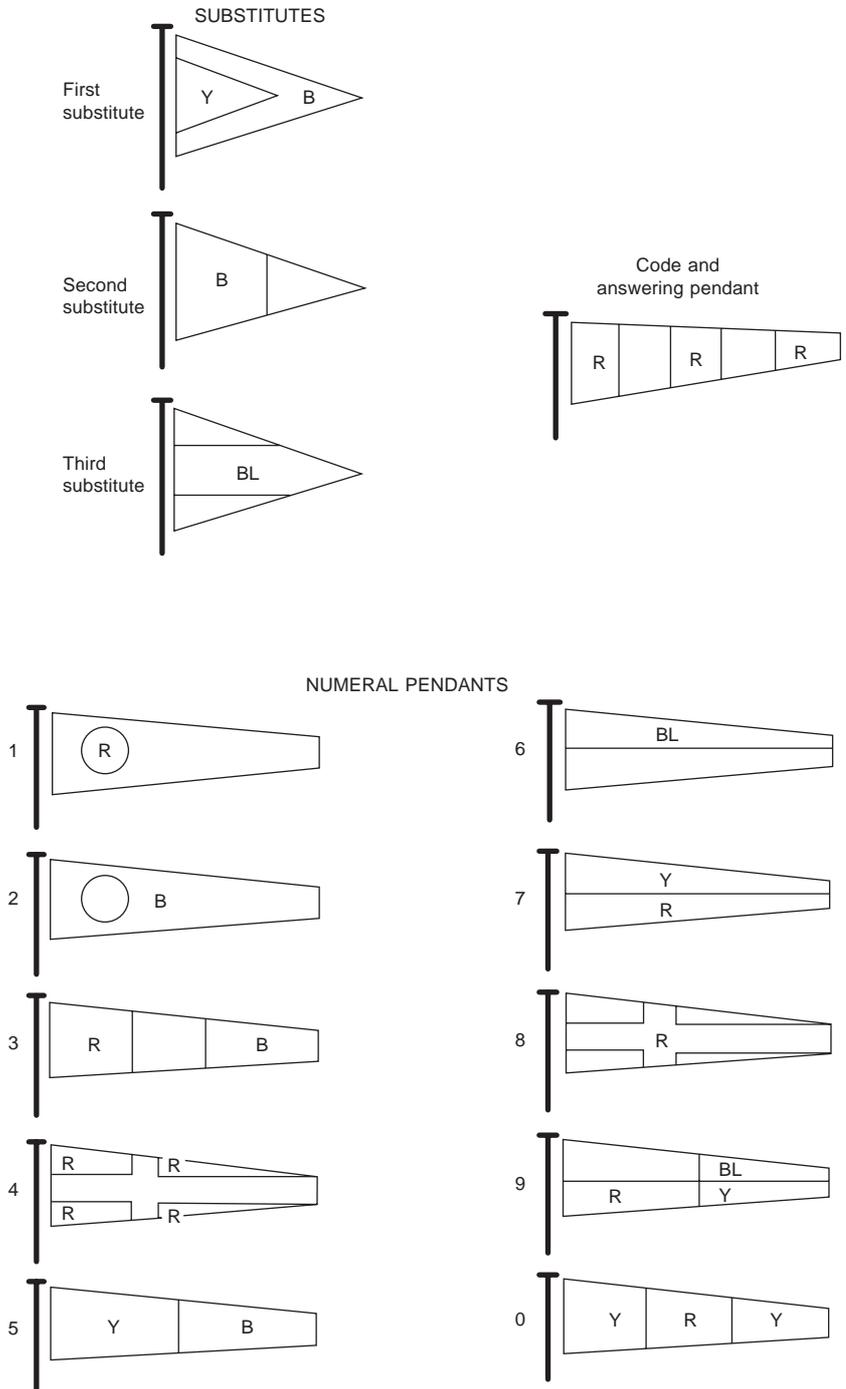


Figure 9.2 Substitutes, code and numeral flags.

The transmitting station should also display its own Signal Letters while calling up the other vessel.

Alternative Call Up

The transmitting station may hoist, instead of the signals listed above:

YQ = 'I wish to communicate by ... (Complements Table 1; Section 1) with vessel bearing from me.' If the signal had been YQ3 = 'I wish to communicate by morse signalling lamp.' The numeral 3 is cross-referenced with complements table.

How to Answer a Signal

The receiving station, once called up, should hoist the answering pendant, at the dip. Once the signal is received and understood, the answering pendant should be closed up. The transmitting station will then haul down the signal while the receiving station returns the answering signal to the dip position and awaits the next signal.

How to End Transmission

The transmitting station will hoist the answering pendant as a single hoist to indicate that the communication is complete. This will be answered in the normal manner by the receiving station.

Signals Not Understood

Should confusion arise during transmission and the signal not be fully understood by the receiving station then that station should not close up the answering pendant but leave it at the dip position. The receiving station may make the following signals when the signal is distinguished but the meaning of it is unclear.

ZQ = 'Your signal appears incorrectly coded. You should check and repeat the whole', or

ZL = 'Your signal has been received but not understood'.

Names and Spelling

Should any signal contain names requiring full spelling, then these names should be spelt out with international code alphabetical flags. If it is felt necessary, then the hoist:

YZ = 'The words which follow are in plain language'

may be used for clarification.

General Notes on Transmission

Signals should always be hoisted in such a manner as to fly clear of obstructions and not be obscured by smoke etc. It is normal practice to exhibit one hoist at any one time, but should it become necessary to exhibit more than the one hoist, two hoists may be flown from the same

halyard provided that they are separated by a length of tackline. The upper of the two groups is the one to be read first.

Order of Transmission with Several Hoists

Should a number of flag hoists be made simultaneously, they should be read in the following order:

1. Signal at masthead.
2. Signal at triatic stay.
3. Signal at starboard yard arm.
4. Signal at port yard arm.

Should there be more than one group flown from the triatic stay, then they should be read from forward to aft. Should several hoists be displayed from the same yard arm, then these should be read from outboard to inboard.

International Code – Use of Substitutes

The purpose of the three substitute flags is to enable a letter or numeral pendant to be repeated in the same hoist. A letter or number may have to be repeated more than once within the same hoist, so there are three substitute flags, not just one.

When a substitute flag is used, it refers only to the hoist in which it is contained. If the first substitute is used, it will mean a repeat of the first letter/numeral flag of the hoist. If the second substitute flag is used, it will mean that the second flag of the hoist, letter or numeral, is repeated. The third substitute indicates that the third flag of the hoist is repeated.

Exceptions with the Use of Substitutes

Many hoists are significant in that they have a prefix letter, e.g. L3640N = Latitude 36° 40' North, the prefix of the hoist being the letter 'L' for Latitude. Similarly a hoist indicating a bearing/azimuth is prefixed by the letter 'A', e.g. A200 = Bearing 200°.

Whenever a hoist containing three or four numerals is made, and there is a prefix letter in front of the hoist, substitute flags should *not* include the prefix letter. See the following examples:

EXAMPLES

1. Bearing 200° = A200 – signal made up as follows:

'A' Flag.
 '2' Numeral.
 '0' Numeral.
 2nd Substitute.

2. Longitude 22° 32' W = G2232W – Signal made up as follows:

'G' Flag.
 '2' Numeral.
 1st Substitute.
 '3' Numeral.
 2nd Substitute.

TABLE 9.1 Examples of flag hoists, International Code of Signals

<i>Flag hoist</i>	<i>Meaning</i>	<i>Reference</i>
'Y'	I wish to communicate by morse signalling lamp.	Complements Table 1
'Q' '3'	Bearing 333.3°	Prefix letter 'A' to indicate bearing. Code flag represents Decimal point. Use of all substitutes.
'A' '3' 1st sub. 2nd sub. Code flag 3rd sub.	True course 115°	Prefix letter 'C', General instructions. All courses are transmitted in three-figure notation. Always expressed as true, unless stated otherwise.
'C' '1' 1st sub. '5'	11 July 1984	Prefix letter 'D', general instructions. First two numerals refer to days. Second two numerals refer to the month. Last two numerals refer to the year.
'D' '1' 1st sub. '0' '7' '8' '4'		

TABLE 9.2 Tables of Complements (found in the International Code of Signals)

<i>Table I: Methods of Communication</i>	8. Vessel to stand by
1. Morse signalling by hand flags or arms	9. Ice breaker.
2. Loud hailer (megaphone)	<i>Table III: Compass Directions</i>
3. Morse signalling lamp	0. Direction unknown (or calm)
4. Sound signals	1. North-east
<i>Table II: Services</i>	2. East
0. Water	3. South-east
1. Provisions	4. South
2. Fuel	5. South-west
3. Pumping equipment	6. West
4. Fire fighting appliances	7. North-west
5. Medical assistance	8. North
6. Towing	9. All directions (or confused or variable).
7. Survival craft	

IMPORTANT TWO-LETTER SIGNALS

- AL I have a doctor on board.
- AN I need a doctor.
- CB I require immediate assistance.
- FR I am (or vessel indicated is) in charge of co-ordinating search.
(Intended for use with SAR activity)
- GU It is not safe to fire a rocket.
- GT I will endeavour to connect with line throwing apparatus.

- LO I am not in my correct position (to be used by a light-vessel).
 NC I am in distress and require immediate assistance.
 NE You should proceed with great caution.
 NO Negative – No – or the significance of the previous group should be read in the negative.
 OK Acknowledging a correct repetition or 'It is correct'.
 RA My anchor is foul.
 SP Take the way off your vessel.
 TJ You should navigate with caution. There are nets with a buoy in this area.
 YG You appear not to be complying with the traffic separation scheme.

SAMPLE MESSAGES EMPLOYING INTERNATIONAL CODE OF SIGNALS

- I am in distress in position 212°T, 15 miles from Morecambe Bay and require a vessel to stand by immediately.
 CC8 A212 MORECAMBE BAY R15.
- My ETA at FOLKESTONE is 0700 BST on 14 December 1980.
 UR FOLKESTONE T0700 D141280
- My position at 1200 GMT was Latitude 50°15'N, Longitude 0°20'W.
 ET Z1200 L5015N G0020W
- I require a helicopter urgently to pick up injured person. Patient has severe burn on central upper abdomen.
 BR3 MGH19.
- I will try to proceed under my own power but request you to keep in contact with me by R/T on 2182 kHz.
 IJ YZ RT 2182
- A tropical storm on course 290°T at 15 knots is centred at Latitude 26°30'N, Longitude 60°16'W at 1800 GMT. NW storm force winds are expected
 VM Z1800 L2630N G6016W C290 S15 VK7.

FLAG MAINTENANCE

Ships' flags are normally stowed on the Bridge or near the Bridge area in an easily accessible flag locker. It is not unusual for modern vessels to carry two flag lockers, one each side of the wheelhouse. Flag halyards are normally stretched to port and starboard bridge wings and the monkey island from the triatic stay. The old-fashioned flag lockers were open to allow easy flag withdrawal, but nowadays open cupboard design is more popular, with protective cupboard door arrangements. The 'pigeon-hole' design of one pocket per flag is still accepted.

Flags should be fitted with brass ininglefield clips, one of the clips being fitted with a swivel fitment. Halyards should be similarly fitted with the clips to facilitate speedy attachment of the hoist (Figure 9.3).

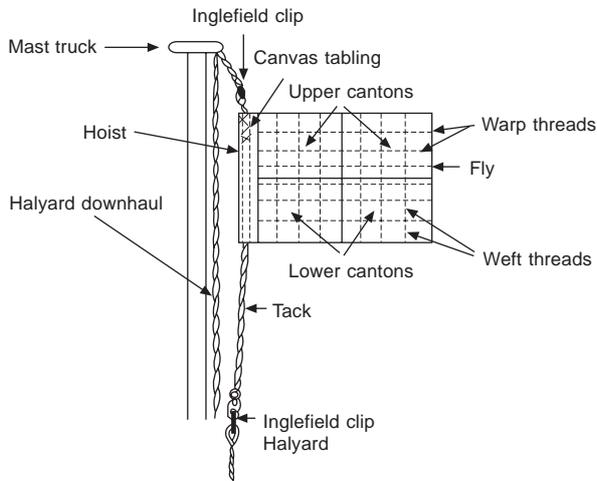


Figure 9.3 Flag construction.

Modern flags are manufactured in a brush nylon fabric; they are washable and light in weight, allowing the flag to fly clear in light winds. Previously flags were manufactured in 'bunting', a wool woven cloth which was and is a lightweight material that does not fray easily. Calico was also used in the past, but proved most unsatisfactory, especially when wet. It was a heavy material basically, but when wet absorbed the water and hung limp in all but heavy winds.

Flags are expensive, and should be treated with care. Inspection of the flag locker at periodic intervals gives the locker and the flags an 'airing', removing any musty smells that may have accumulated.

Flags should be thoroughly dried preferably by natural rather than artificial means, before being stowed away. Nylon fabric flags are washable and, provided they have not started to fray around the 'fly' edge, will last for many years. The older style 'bunting' can be washed in fresh water, but strong detergents should be avoided. Bunting is not as hard wearing as the synthetic material and more liable to rot, especially if oil contaminates the fabric.

WEARING OF ENSIGNS

White Ensign

The flag is flown by all ships of Her Majesty's Navy when in commission or when being launched, and by RN shore establishments when commanded by a commissioned officer.

Royal Standard

This is the personal flag of the Sovereign and should be flown only when the sovereign is present aboard the vessel. It should be exhibited at the mainmast, and in a vessel without a mainmast the flag should be flown from the most conspicuous part of the vessel.

Personal Royal Standards

These are exhibited in a similar manner to the Royal Standard. Other members of the Royal Family than the Queen, e.g. the Prince of Wales, may appropriately use a personal standard when visiting aboard ships.

Jack (often referred to as the pilot jack)

This name may have been derived from King James I, who signed his name 'Jackques' and under whose instructions the flag was constructed. It was always flown from the 'jackstaff at the stem'. Ships of the Royal Navy fly a square or rectangular union flag, whereas the merchant navy tends to exhibit a small 'pilot jack'. A union flag, surrounded by a white border, is also flown from the jackstaff.

Originally the flying of the pilot jack meant that the ship required a pilot, but this requirement is now indicated by the International Code Flag 'G'. The flying of the 'jack' in the forepart is generally restricted to times when the vessel is in harbour, either alongside or at anchor.

House Flag

This flag is flown by merchant vessels to indicate their ownership or the company that has chartered the vessel. It will bear the company's insignia and will normally be flown when entering or leaving port, or when the vessel is at anchor. It is generally exhibited at the masthead, but has in the past been flown at the stem on the jackstaff.

Courtesy Flag

It is general practice for merchant vessels to fly the colours of the country the vessel is visiting as a mark of respect to the host nation, and care should be taken not to fly the flag incorrectly. Nowadays the courtesy ensign is flown from the starboard yard arm. Previously it was broken out at the forward masthead.

Blue Ensign

British ships of the mercantile marine are allowed to fly the blue ensign, provided that the following conditions are complied with:

1. The master or officer in charge of the vessel is an officer on the retired or emergency list of the Royal Navy or the Royal Australian Navy; or an officer of the Royal Navy Reserve, the Royal Australian Naval Reserve (Seagoing), the Royal Canadian Naval Reserve or the Royal Naval Reserve (New Zealand Division).
2. Crew members, in addition to the officer commanding, must include members and officers of the following: Royal Naval Reserve, Royal Australian Naval Reserve (Seagoing), Royal Canadian Naval Reserve, or Royal Naval Reserve (New Zealand Division). The total numbers are specified by the Admiralty at periodic intervals, and may also include Royal Fleet Reservists of the British, Australian and New Zealand Fleets, together with persons holding deferred pensions from the Royal Naval Reserve and the Royal Navy.

3. Before hoisting the blue ensign the commanding officer must be in possession of an Admiralty warrant indicating this entitlement. Royal Naval Reserve officers wishing to apply for the Admiralty warrant should in the first instance make application to the local Mercantile Marine Office.
4. The ship's articles of agreement should bear a statement to the fact that the commanding officer of the vessel is authorised to hoist the blue ensign, and holds the warrant from the Admiralty.

British merchant ships requisitioned by the Admiralty to assist in operations will also be allowed to fly the blue ensign, under the Admiralty warrant. Application to do so must be made by the owners of the vessel to the Admiralty, through the Registrar General of Seaman.

Red Ensign

This is the national ensign of the United Kingdom flown by all vessels owned by British subjects other than Her Majesty's ships. It is normally flown by all merchant vessels when in port or at anchor from the ensign staff at the after end of the vessel. When at sea it is flown at the peak of the 'gaff' of the aftermast. If the vessel is not fitted with an aftermast or gaff, the ensign may be flown from the ensign staff aft.

The ensign should never be 'broken out' at the masthead. When hoisting, it should always be hauled 'close up' and maintained on a tight halyard. It should be exhibited when:

- (a) entering and leaving any foreign port,
- (b) entering or leaving any British port (if the vessel is over 50 tonnes),
or
- (c) when in contact or communication with a naval vessel.

The national colour of a ship of any nation should be flown in port between 0800 hrs and sunset between 25 March and 20 September, and from 0900 hrs to sunset between 21 September and 24 March.

If a vessel is entering or leaving port, or coming into an anchorage, it is customary to leave the ensign flying until the operation of anchoring or berthing has been completed. Should this occur after the time of sunset, the colours are struck as soon as is practicable.

Dipping the Ensign

This is a salute made to naval vessels. Traditionally it was to indicate that the vessel dipping her ensign was engaged on peaceful and lawful trade.

Dipping the ensign means to lower the colours from the 'close up' position to the 'dip' position. This signal should be acknowledged and answered by the receiving vessel by lowering her own ensign to the dip and immediately returning it to the 'close up' position. Once this action is seen by the saluting vessel, then she should return her own ensign to the close up position.

TABLE 9.3 Phonetic alphabet and figure spelling

<i>Letter</i>	<i>Word</i>	<i>Pronunciation</i>	<i>Number</i>	<i>Word</i>	<i>Pronunciation</i>
A	Alfa	Al Fah	0	Nadazero	Nah Dah Zay Roh
B	Bravo	Brah Voh	1	Unaone	Oo Nah Wun
C	Charlie	Char Lee	2	Bissotwo	Bees Soh Too
D	Delta	Dell Tah	3	Terrathree	Tay Rah Tree
E	Echo	Eck Oh	4	Kartefour	Kartay Fower
F	Foxtrot	Foks Trot	5	Pantafive	Pan Tah Five
G	Golf	Golf	6	Soxisix	Sok See Six
H	Hotel	Hoh Tell	7	Setteseven	Say Tay Seven
I	India	In Dee Ah	8	Oktoeight	Ok Toh Ait
J	Juliett	Jew Lee Ett	9	Novenine	No Vay Niner
K	Kilo	Key Loh			
L	Lima	Lee Mah	Decimal		
M	Mike	Mike	point	Decimal	Day See Mal
N	November	No Vem Ber			
O	Oscar	Oss Car			
P	Papa	Pah Pah			
Q	Quebec	Keh Beck			
R	Romeo	Row Me Oh			
S	Sierra	See Air Rah			
T	Tango	Tang Oh			
U	Uniform	You Nee Form			
V	Victor	Vik Tah			
W	Whiskey	Wiss Key			
X	X-Ray	Ecks Ray			
Y	Yankee	Yang Key			
Z	Zulu	Zoo Loo			

MORSE CODE PROCEDURE — SIGNALLING BY FLASHLIGHT

The following are some procedural signals:

- AA AA AA etc. = Call for an unknown station or general call.
- EEEEEEEEEE etc. = Erase signal.
- AAA = A full stop or a decimal point.
- TTTTTT etc. = The answering signal.
- T = Word or group has been received.

To Call an Unknown Station

The general call AA AA AA etc. is made by the transmitting station to attract the attention of all other stations within visible range. This transmission is continued until the required station answers. The directional light of an Aldis lamp provides a more distinctive identification than, say, an all-round signalling lamp if several stations are in close proximity. Should the call sign or identity of the receiving station be known, then the identity signal of that station may be used as an alternative to the general call.

To Answer the Transmitting Station

The call-up transmission is answered by TTTTTT etc. (a series of 'Ts') and

TABLE 9.4 International Morse Code

<i>Letter</i>	<i>Symbol</i>	<i>Number</i>	<i>Symbol</i>
A	• —	1	• — — — —
B	— • • •	2	• • — — —
C	— • — •	3	• • • — —
D	— • •	4	• • • • —
E	•	5	• • • • •
F	• • — •	6	— • • • •
G	— — •	7	— — • • •
H	• • • •	8	— — — • •
I	• •	9	— — — — •
J	• — — —	0	— — — — —
K	— • —		
L	• — • •		
M	— —		
N	— •		
O	— — —		
P	• — — •		
Q	— — • —		
R	• — •		
S	• • •		
T	—		
U	• • —		
V	• • • —		
W	• — —		
X	— • • —		
Y	— • — —		
Z	— — • •		

this answer should continue until the transmitting station stops transmitting the call-up signal.

Message Transmission

The receiving station should acknowledge receipt of each group or word of the message by the single transmission of the letter 'T'. The message should be concluded by the signal AR by the transmitting station. On receipt of the AR, the receiving station will signal 'R' to signify that the 'message has been received'.

MORSE CODE REGULAR PROCEDURAL SIGNALS

- AA 'All after . . . ' (used after the 'repeat signal' (RPT) means 'Repeat all after . . . '
- AB 'All before . . . ' (used after the 'repeat signal' (RPT) means 'Repeat all before . . . '
- AR Ending signal or end of transmission or signal.
- AS Waiting signal or period.
- BN 'All between . . . and . . . ' (used after the 'repeat signal' (RPT)) means 'repeat all between . . . and . . . '
- C Affirmative – Yes or 'The significance of the previous group should be read in the affirmative'.
- CS 'What is the name or identity signal of your vessel (or station)?'.
- DE 'From . . . ' (used to precede the name or identity signal of the calling station).
- K 'I wish to communicate with you' or 'Invitation to transmit'.
- NO Negative – NO or 'The significance of the previous group should be read in the negative'. When used in voice transmission, the pronunciation should be 'NO'.
- OK Acknowledging a correct repetition or 'It is correct'.
- RQ Interrogative, or 'The significance of the previous group should be read as a question'.
- R 'Received' or 'I have received your last signal'.
- RPT Repeat signal, 'I repeat', or 'Repeat what you have sent' or 'Repeat what you have received'.
- WA 'Word or group after . . . ' (used after the 'repeat signal' (RPT)) means 'Repeat word or group after . . . '
- WB 'Word or group before . . . ' (used after the 'repeat signal' (RPT)) means 'Repeat word or group before . . . '.

MORSE CODE SIGNALLING BY HAND FLAGS OR ARMS

Figure 9.4 illustrates this signalling method.

To Call Up a Station

The general call sign may be made by the transmitting station – AA AA AA. An alternative call up signal may be the transmission of K1 by any means, meaning 'I wish to communicate with you by morse signalling by hand-flags or arms'.

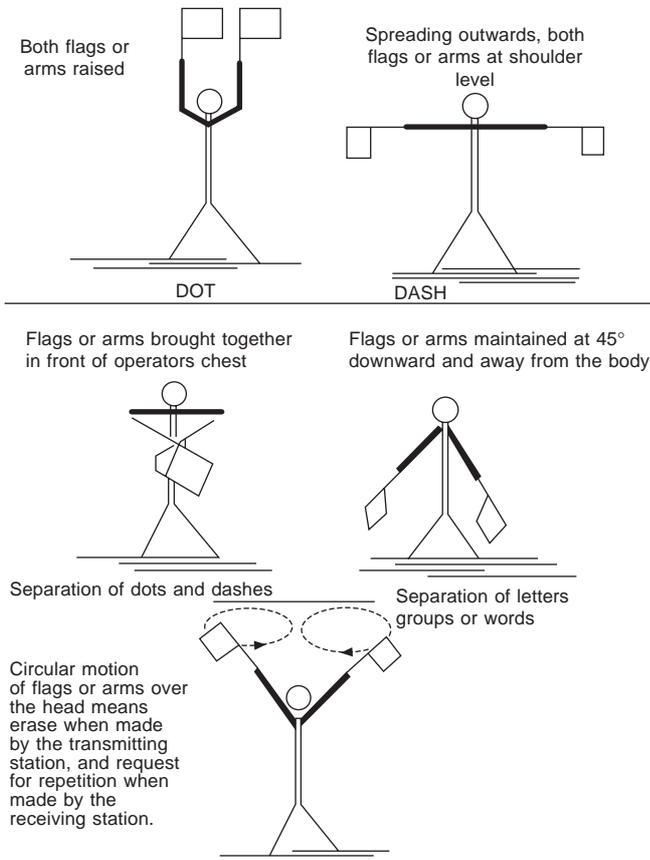


Figure 9.4 Morse signalling by hand flags or arms.

A Receiving Station – In Answer

On receiving the call-up signal the receiver should answer the call by the answer signal – TTTTT. Should a receiving station be unable to communicate by this method, the signal YS1 should be displayed by any available means, meaning ‘I am unable to communicate by morse signalling by hand-flags or arms’.

Completing the Signal

All signals are completed by the transmission of the ending signal – AR.

This method of signalling can be carried out by flags or just by the operator’s arms, and if the operator has only one arm available, the system is still feasible. But it is tiring and time-consuming, and unpopular with mariners.

APPENDIX

SEAMAN'S SELF-EXAMINER



The headings indicate the examinations to which the following questions and answers are directed.

EFFICIENT DECK HAND

1. **Qu.** What are the natural fibre ropes called?
Ans. Manilla, hemp, sisal, coir and cotton.
2. **Qu.** What is the construction of log line?
Ans. Sennet laid hemp.
3. **Qu.** Describe hawser layed rope?
Ans. Three-stranded rope laid up left- or right-handed.
4. **Qu.** How would you commence a back splice in a natural fibre rope before starting the normal tucks?
Ans. By use of a crown knot.
5. **Qu.** What are the main differences between the construction of a flexible steel wire rope and a non-flexible steel wire rope?
Ans. A flexible wire will have more wires per strand and a fibre heart running through the centre. Non-flexible wires do not possess the fibre heart and have less wires per strand.
6. **Qu.** What is the difference between a 'hard eye' and a 'soft eye', when splicing?
Ans. A hard eye will have a thimble spliced into the rope or wire, and a soft eye will just be the rope or wire spliced to itself.
7. **Qu.** What would you expect to find stamped on the binding of a metal block?
Ans. The safe working load of the block and the block's certificate number.
8. **Qu.** What would you use to mouse a shackle?
Ans. Seizing wire.
9. **Qu.** How would you make a 'temporary eye' in the end of a rope?
Ans. By means of a bowline.

-
10. **Qu.** What is the length of a 'shackle of cable'?
- Ans.** 15 fathoms or 90 ft.
11. **Qu.** Where would you expect to find a 'monkey's fist'?
- Ans.** In the end of a heaving line to weight the end when throwing.
12. **Qu.** How would you secure a bosun's chair to a gantline, prior to working aloft?
- Ans.** By use of a double sheetbend.
13. **Qu.** With what tool would you open up the lay of a rope when splicing? Explain why a marline spike would not be used.
- Ans.** A wood 'fid' is used for splicing ropes. If a marline spike was employed, the fibres of the rope would be cut against the metal tip of the spike, which would considerably weaken the finished splice.
14. **Qu.** When coming to a single anchor with your vessel what would you consider to be good holding ground for the anchor?
- Ans.** Mud, clay or hard sand are all considered to be good holding grounds.
15. **Qu.** When worming, parcelling and serving, why would you not use marline for the operation of 'worming'?
- Ans.** Marline will not compress under the parcelling and an uneven finish would result.
16. **Qu.** How would you join two wire hawsers together for the purpose of 'towing', without eye splicing one to another?
- Ans.** Secure both hawsers by means of a 'carrick bend'.
When towing, the hawsers could be expected to take a considerable amount of weight. Allow the weight to be taken up first, before seizing the tails down to the standing parts, or the seizings may be pulled adrift.
17. **Qu.** What are the main functions and purpose of locking bars when battening down conventional hatches?
- Ans.** The locking bars prevent the tarpaulins from blowing off in the wind. They also act to retain the hatch boards (wood) from floating off should the hatch become full of water. Locking bars may also be considered an anti-theft device.
18. **Qu.** What is the safe working angle between the two cargo runners considered to be, when working union purchase?
- Ans.** The safe working angle between the runners is 90°. The rig can also work up to 120° without incurring excessive stress for the occasional lift.
19. **Qu.** Where would you expect to find the 'bitter end' aboard a vessel?
- Ans.** In the chain cable locker. The 'bitter end' is the very end of the cable secured in or just outside the chain locker.
20. **Qu.** If a tackle was rove to advantage, would you be pulling on the downhaul from the standing or from the moving block?
- Ans.** From the moving block.

21. **Qu.** When would you encounter a 'union plate', sometimes referred to as a monkey face plate?
Ans. When handling derricks. The union plate connects the bull wire chain preventer and the single span topping lift at one point.
22. **Qu.** What is the function of tank top ceiling, and in what type of vessel would you expect to encounter it?
Ans. The tank top ceiling is a wooden sheathing to protect the tank top of the double bottom. It is normally found in general cargo vessels situated in way of the hatchway, at the bottom of the hold. Not only will it afford protection from heavy loads, but, depending on its design, it may well assist in drainage and ventilation of cargoes.
23. **Qu.** How could a bottle screw (turnbuckle) be locked and secured?
Ans. (a) By means of an adjustable locking bar.
 (b) By means of locking nuts on to the screw threads.
 (c) By means of seizing wire turned about through the centre and the end eyes.
24. **Qu.** Give an example of when a 'solid thimble' would be employed, and state why you would use it as opposed, say, to an open heart thimble?
Ans. A solid thimble is used in 'standing rigging', e.g. stays, shrouds. The rigid securing when the solid thimble is employed resists any movement of the bolt of the securing shackle.
25. **Qu.** What prevents the lead pellet which retains in the spile pin of a 'Kenter Lugless Joining Shackle' from falling out?
Ans. The lead pellet is inserted over the spile pin into a 'dove tail recess', which prevents the pellet from coming adrift accidentally.

CERTIFICATE OF PROFICIENCY IN SURVIVAL CRAFT AND RESCUE BOATS

1. **Qu.** What types of wooden-built lifeboats do you know?
Ans. Clinker, carvel and double diagonal.
2. **Qu.** How many boathooks are required in lifeboats?
Ans. Two.
3. **Qu.** Where would you find the 'garboard strake'?
Ans. It is the first strake outward from the keel.
4. **Qu.** How long are the painters of a ship's lifeboat?
Ans. As long as necessary to allow the boat to be safely launched at lightest seagoing draught.
5. **Qu.** What pyrotechnics would you expect to find in the lifeboat?
Ans. Six hand held flares, four rocket parachute flares and two orange smoke floats.
6. **Qu.** How would you recognise the 'steering oar' in a ship's lifeboat?

- Ans.** The blade of the oar would be painted a distinctive colour. The blade should also be facing aft. The steering oar is also approximately 12 to 14 in. longer than other oars.
7. **Qu.** If you were the cox'n of the only motorised survival craft to be launched after a disaster, what would be your major function.
- Ans.** Collect and assemble all other survival craft. This would enable a roll call to be made of known survivors. The action would also provide a larger target for rescue craft to see. One of the other craft may have an emergency radio and in any event life support systems can be jointly used for the survival of all.
8. **Qu.** How would you take a reef in lifeboat sails?
- Ans.** Down helm, head the boat into the wind, and let fly the sheets. Stream the sea anchor to keep to boat's head up wind. Lower the yard and lay it on to the side benches of the boat. Clear the foot of the sail. Secure the luff and leach earrings, respectively to the tack and clew cringles. Commence to secure the reef points about the bunched sail, starting to tie the reef knots from the forward end to aft. Secure the yard strop to the traveller and reset the sails. Trip the sea anchor and resume course.
9. **Qu.** How long is the tripping line of the sea anchor found in the ship's lifeboats?
- Ans.** About 2 fathoms longer than the sea anchor hawser.
10. **Qu.** Of what construction would you expect wire lifeboat falls to be. How often would you expect them to be renewed?
- Ans.** Extra flexible steel wire rope (6 × 36 or 17 × 7) wps. To be renewed whenever required, and at no greater than at a five-yearly interval.
11. **Qu.** What is the purpose of the 'tricing-in pennants' on the davits of lifeboats?
- Ans.** The tricing-in pennants are secured to bring the boat alongside the embarkation deck particularly when the mother vessel has an adverse list.
12. **Qu.** What types of life raft are popularly employed in the marine industry?
- Ans.** The rigid raft, the inflatable raft, and the davit-launched raft.
13. **Qu.** What is the standard length of painter fitted to an inflatable life raft? Can this length ever differ?
- Ans.** The standard length is 25 m (80 ft). This length can be increased by order to the manufacturer if so desired, e.g. for high freeboard vessels.
14. **Qu.** Three life rafts are located together. Would you attempt to join up the rafts and if so at what distance would you connect them together?
- Ans.** Yes, you would under normal circumstances join the rafts

- together. They should be secured as far apart as possible so as to avoid the painters snatching and parting when in any sea and/or swell.
15. **Qu.** What is the release gear for the davit-launched life raft called, i.e. the gear found at the end of the fall above the raft?
Ans. Mills Atlas Release Gear.
16. **Qu.** At what angle of adverse list must a davit-launched raft be capable of being launched?
Ans. 20° of adverse list.
17. **Qu.** How would you attempt to beach a life raft?
Ans. As follows, during the hours of daylight and on a gently sloping beach, if circumstances permit:
 (a) Inflate the floor of the raft.
 (b) Stream both sea anchors (drogues).
 (c) Open up the entrances and man the paddles.
 (d) See that all personnel are wearing lifejackets.
18. **Qu.** When in a life raft, what would you use the *two* sponges for?
Ans. One sponge should be used after the bailing to dry the inside floor area of the raft. The other sponge should be used to collect condensation from the inside canopy for drinking use.
19. **Qu.** What is the breaking strain of the weak link of the hydrostatic release system?
Ans. 500 lb ± 100 lb or 227 kg ± 45 kg.
20. **Qu.** After a raft has been launched, how would you get it away from the ship's side?
Ans. Cut the painter, and use both paddles. If the raft is of a circular design, use of the paddles may prove difficult. In that case use them in conjunction with a heavy object placed in the sea anchor: throw the sea anchor at right-angles to the fore and aft line of the vessel, then pull the raft towards the sea anchor.
21. **Qu.** What markings would you expect to find on the outside canister of an inflatable life raft?
Ans. The maker's name, an indication as to the *top* of the canister, the capacity of the raft (number of persons to be carried), the length of painter, date of last service, date of next service, statement whether raft complies with SOLAS regulations, instructions for launching, do not roll symbol if fitted with aerial facility.
22. **Qu.** How often are life rafts and hydrostatic release units surveyed and by whom?
Ans. Every twelve months by a Department of Trade approved agency.
23. **Qu.** What is the emergency boat muster signal?
Ans. Seven or more short blasts on the ship's bells and whistles, followed by a continuous long ringing/sounding of each.

PART TWO



SHIP HANDLING

CONTENTS TO PART TWO



Acknowledgments	vii
List of plates	ix
List of tables	xi
1. <i>WATCHKEEPING DUTIES</i>	
Master's responsibilities	1
Watchkeeping – general duties	3
Duties of the officer of the watch (OOW)	3
Duties of the lookout	5
Duties of the helmsman	6
Duties of the standby man	7
Official publications	9
Rigging pilot ladders	15
Mechanical pilot hoists	17
Ship to shore transit	20
2. <i>SPEED AND DEPTH</i>	
Patent rotator log	21
Impeller log	24
Hand lead	25
Echo-sounding	26
3. <i>MARINE INSTRUMENTS</i>	
Sextant	30
Marine chronometer	35
The gyro compass	36
Magnetic compass	41
Liquid magnetic compass	42
Dry card magnetic compass	48
Azimuth mirror	49
Pelorus	50
Hydrometer	52

	Hygrometer	53
	Precision aneroid barometer	53
4.	<i>METEOROLOGY</i>	
	Meteorological terms	57
	Forecast areas	65
	Weather scales	65
	Construction and interpretation of synoptic chart	66
	Contingency plans for heavy weather	69
	Effects of heavy weather on vessel at sea	71
	General behaviour of vessels in heavy weather	72
	Tropical revolving storm	76
	Ice terminology	78
	Ice navigation	83
5.	<i>PREVENTING COLLISIONS AT SEA</i>	
	International regulations	86
	Judging another vessel's heading at night	124
	Special cases to rule of the road	125
	Rule of the road – questions and answers	129
	IALA maritime buoyage systems 'A' and 'B'	132
6.	<i>EMERGENCIES</i>	
	Collision	137
	Flooding	139
	Abandonment from the vessel	141
	Rescue and recovery of survivors	143
	Stranding	145
	Breaching procedure	145
	Deck department checklist for watertight integrity of hull following grounding or beaching	147
	Engine room department checklist for machinery spaces following grounding or beaching	147
	Watertight doors	148
	Drydock procedure	150
	Man overboard	153
	Helicopter procedure	156
	Steering gear failure or loss of rudder	161
	Subsunk, procedure	164
7.	<i>FIRE-FIGHTING</i>	
	Small fires	166
	Accommodation fires at sea	168
	Galley fires at sea	169
	Machinery space fires at sea	171
	Cargo space fires at sea and in port	174
	Paint room fires	177
	Fixed fire-fighting installations	178

International shore connection	183
Self-contained breathing apparatus	183
Example: Cargo fires	185
8. <i>SEARCH AND RESCUE OPERATIONS</i>	
Action by vessel in distress	189
Master's obligations	190
Obligations of rescuing craft	190
When assistance is no longer required	191
Searching the sea	191
Aircraft in distress	192
Communications between surface craft and aircraft	192
Surface to surface rescue	193
Pyrotechnics	196
Breeches buoy	200
Communications	203
HM Coastguard	204
AMVER organisation	207
Abbreviations	209
9. <i>SHIP-HANDLING</i>	
Terms and general definitions	210
Factors in ship-handling	212
Rudders	213
Propellers	215
Turning circles	219
Bow/stern thruster units	223
Fin stabilisers	225
Manoeuvring with mooring lines	227
Fairleads	227
Bollard (bitts)	227
Rigging slip wires or ropes	228
Berthing	230
Clearing a berth	230
Entering dock	232
Securing to buoys	232
Mooring	233
Letting go from buoys	233
Turning vessel short round	234
Open moor	236
Interaction	240
Shallow water effects and squat	241
Working with tugs	242
10. <i>TANKER WORK AND OIL POLLUTION</i>	
Tanker vessels	249
Tanker hazard and precautions	250
Dangers of petroleum spirit	252

General definitions	254
Cargo-handling equipment	255
Whessoe tank gauge	257
General operations and procedures	258
Tanker layout and ventilation	261
Health and safety	261
Inert gas system	269
Mooring large tankers	274
Oil pollution	276
Appendix to Chapter 10	287
Appendix: Seaman's self-examiner	
Officer of Watch Certificate (OOW)	289
Class 2 Certificate of Competency (Oral)	292
Certificate of Competency for Master Mariner, Class 1	297
Index to Part One	309
Index to Part Two	317

ACKNOWLEDGMENTS TO PART TWO



I would like to express my appreciation and thanks to the following for their assistance in supplying diagrams, photographs and information relevant to this work.

Anschutz & Co., GMBH
Henry Brown & Son Ltd
Ateliers et Chantiers de Bretagne – ACB
The British Broadcasting Corporation
Pains Wessex Schermuly Ltd
John Cairns Ltd (for extracts from the *International Manual of Maritime Safety* and *The S.O.S. Manual*)
United States Coastguard
HM Coastguard – Maritime Rescue Sub Centre Formby, Liverpool
Thomas Mercer Chronometers Ltd
Whessoe Systems and Controls Ltd
Negretti & Zambra (Aviation) Ltd
AFA – Minerva Ltd., Marine and Offshore Division
Thomas Walker & Son Ltd
AGA Spiro Ltd
Siebe Gorman & Company Ltd
Elliott Turbomachinery Ltd/White Gill Bow Thrusters
Butterworth Systems (UK) Ltd
J.M. Voith GmbH
Wagner Engineering Associates Ltd
Sperry (Marine Systems) Ltd
General Council of British Shipping
Heien – Larssen A/S
Department of Trade
Hydrographic Department of the Navy

Stanford Maritime Ltd., for references from *Tugs* by Captain Armitage and from *Basic Shiphandling for Masters & Mates*, by P.F. Willerton

The Motor Ship (published by IPC Industrial Press Ltd)

Schilling Rudders

F.R. Hughes & Co., Ltd

PLATES TO PART TWO



1. Modern bridge	2
2. Radar reflector unit	4
3. Primary action of the officer of the Watch is to maintain a continuous and effective lookout	6
4. Accommodation ladder	19
5. Department of Trade gangway	19
6. Walker's Excelsior log clock	22
7a. Marine sextant	31
7b. Marine chronometer	35
8. Binnacle in hardwood finish	41
9. Modern binnacle manufactured in GRP	42
10. Liquid compass bowl in gimball arrangement	44
11. Reflector unit	47
12. Azimuth mirror	48
13. Pelorus	51
14. Conventional aneroid barometer	55
15. Precision aneroid barometer	56
16. Marine barograph	56
17. Small iceberg in open water	80
18. Pack ice conditions	85
19. Operational offshore installation	127
20. Removal of propeller in drydock	150
21. Ship on blocks in drydock	151
22. Emergency bridge lifebuoy	154
23. Westland/Sikorsky S61N helicopter	156
24. Wessex Mk 5, helicopter of the Royal Air Force	158
25. Sikorsky HH-60J Jayhawk helicopter	160
26. RAF Wessex helicopter with aircrew actively engaged on the recovery wire	209
27. New hull design has caused major changes	220
28. Bow thrust units	224

29.	Vessel moored at quayside	234
30.	Cruise ship moored	237
31.	Gob rope on tug	244
32.	Alternative type of gob rope	245
33.	Bow section showing Panama Lead	248

TABLES TO PART TWO



1.1	Example of helm orders	8
1.2	Example of four-hour watch operated by three men	9
1.3	Entries in oil record book	13
4.1	Beaufort Wind Scale	67
4.2	Beaufort weather notation	68
4.3	Wave scale	68
6.1	Helicopters	158
7.1	Extinguishing agents	167
8.1	Emergency signals	191
10.1	Ship/shore (tanker) officer's example checklist	253

WATCHKEEPING DUTIES



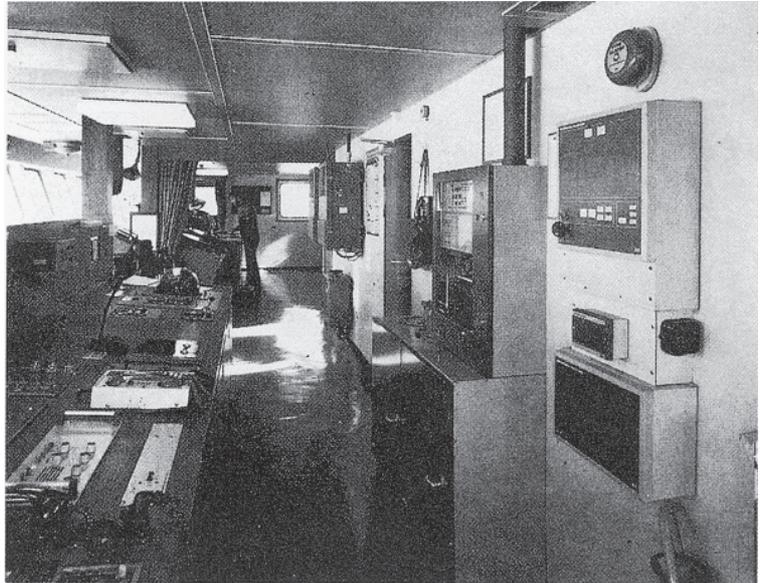
MASTER'S RESPONSIBILITIES★

It is the duty of every Master to ensure that the watchkeeping arrangements for his ship are adequate for maintaining a safe navigational watch. All watchkeeping officers are the Master's representatives and are individually responsible for the safe navigation of the vessel throughout their period of duty.

It falls to the Master of the vessel that watch arrangements are such that:

1. At no time shall the Bridge (Plate 1) be left unattended.
2. The composition of the watch is adequate for the prevailing circumstances and conditions.
3. Watchkeepers are capable and fit for duty, and in no way fatigued in such a manner as to impair their efficiency.
4. At all times a proper lookout is maintained by sight and hearing, as well as by all other available means.
5. The Master is aware of all navigational hazards that may make it necessary for the officer of the watch to carry out additional navigational duties. During such periods ample personnel should be available to provide full coverage for all duties.
6. The Master is satisfied that watchkeeping personnel are familiar with all navigational equipment at their disposal.
7. The voyage is well planned beforehand and all courses laid down are checked in advance.
8. Correct hand-over and relief watchkeeping procedures are in practice.
9. The limitations of the vessel and its equipment are known to watchkeeping personnel.
10. When navigating under the advice of a pilot, the presence of that pilot in no way relieves the Master or the officer of the watch of their duties and obligations for the safe navigation of the vessel.

★Based on recommendations published by IMO.



1. Modern wide bridge design. A Minerva fire-detection unit may be seen on the after bulkhead opposite the control console.

The Master should further be aware that the protection of the marine environment is a major consideration. He should take all necessary precautions to ensure that no operational or accidental pollution of the environment takes place, being guided in this matter by the existing international regulations.

Checklist of Items for Passage Appraisal

1. Select largest scale appropriate charts for the passage.
2. Check that all charts to be used have been brought up to date from the latest information available.
3. Check that all radio navigational warnings affecting the area have been received.
4. Check that sailing directions and relevant lists of lights have been brought up to date.
5. Estimate the draught of the ship during the various stages of the passage.
6. Study sailing directions for advice and recommendations on route to be taken.
7. Consult current atlas to obtain direction and rate of set.
8. Consult tide tables and tidal atlas to obtain times, heights and direction and rate of set.
9. Study climatological information for weather characteristics of the area.
10. Study charted navigational aids and coastline characteristics for landfall and position monitoring purposes.
11. Check the requirements of traffic separation and routeing schemes.
12. Consider volume and flow of traffic likely to be encountered.

13. Assess the coverage of radio aids to navigation in the area and the degree of accuracy of each.
14. Study the manoeuvring characteristics of the ship to decide upon safe speed and, where appropriate, allowance for turning circle at course alteration points.
15. If a pilot is to be embarked, make a careful study of the area at the pilot boarding point for pre-planning intended manoeuvres.
16. Where appropriate, study all available port information data.
17. Check any additional items which may be required by the type of ship, the particular locality, or the passage to be undertaken.

WATCHKEEPING – GENERAL DUTIES

Various duties are carried out by watchkeepers either individually or as a team. Experience has shown that the bridge becomes the operational centre for the watch period, with all relevant information and orders processed through it.

The deck log book is maintained on the bridge by the officer of the watch (OOW), together with continual observation and supervision of the following items:

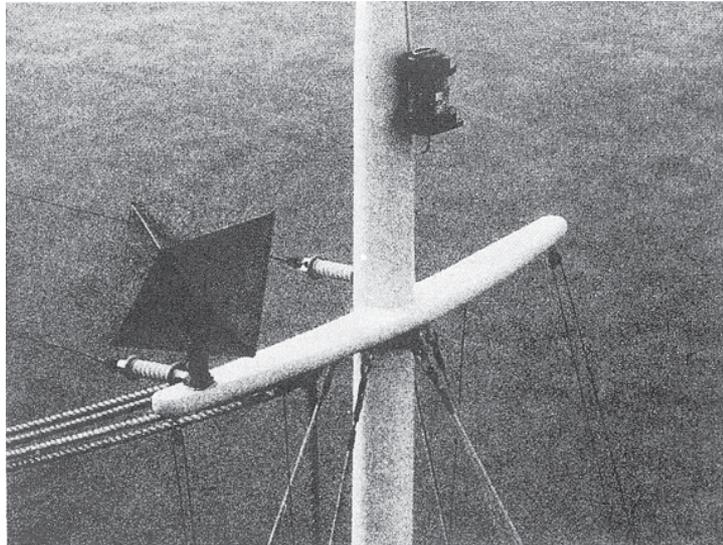
- (a) Watertight integrity of the hull, together with the opening and closing of watertight doors.
- (b) Fire watch, with continual observation of smoke detector systems.
- (c) Special cargo surveillance, as and when required.
- (d) Correct display of all lights and shapes.
- (e) Weather conditions affecting the ship and its course.
- (f) Routine working of the deck, inclusive of rigging pilot ladders, streaming logs, organising boat and fire drills etc.
- (g) All emergencies affecting the safety of the vessel.

DUTIES OF THE OFFICER OF THE WATCH (OOW)

He must supervise the efficient running of the watch and ensure the safe navigation of the vessel throughout the watch period, his main duty being to maintain a proper lookout whenever the vessel is at sea, regardless of other personnel engaged on a similar duty. His navigational duties include the regular checking of the ship's course and the comparison of the gyroscopic compasses with the magnetic compass. The former should be checked by obtaining the compass error at least once a watch or on every alteration of the vessel's course.

The position of the ship should be plotted at regular intervals. Depending on the circumstances, the time interval between separate positions will vary, especially when navigating in coastal waters.

Traffic avoidance is of prime importance in the safe navigation of the vessel throughout the passage time. The OOW should use all available means at his disposal to ensure the safe passage of the vessel and should not hesitate to use any of the following if required: whistle, engines,



2. Radar reflector unit.

radar, additional manpower, helmsman, or anything else considered necessary for the safety of the vessel.*

The OOW should make full use of navigational aids such as echosounder, whenever possible to check navigational accuracy. Radar plotting should be carried out in good weather as well as in foul to ensure that the mariner becomes proficient in the correct plotting techniques.

Any watch officer should also be aware of the ship's capabilities in the way of 'turning circles' and emergency stop distances. He should not hesitate to summon the Master at any time, day or night, should he require assistance. In any event the Master should be kept informed by the officer of the watch of all the movements and events affecting the vessel's progress.

Calling the Master

The officer of the watch should notify the Master immediately in the following circumstances:

- (a) If restricted visibility is encountered or suspected.
- (b) If the traffic conditions or the movements of other vessels are causing concern.
- (c) If difficulty is experienced in maintaining course.
- (d) On failure to sight land or navigation mark, or to obtain soundings by the expected time.
- (e) If land or navigation mark is sighted or a change of soundings occurs unexpectedly.

*Further reading: IMO *Recommendations on Navigational Watchkeeping*.

- (f) On the breakdown of the engines, steering gear or any essential navigational equipment.
- (g) In heavy weather, or if in any doubt about the possibility of weather damage.
- (h) In any other emergency or situation in which he is in any doubt.

The requirement for the OOW to call the Master in the above situations does not relieve him of taking any immediate action necessary for the safety of the vessel.

DUTIES OF THE LOOKOUT

The principal duty of the lookout is to maintain a continuous watch for all hazards that may impair the safe navigation of the vessel (Figure 1.1). He is obliged to give his full uninterrupted attention to this duty, reporting any of the following to the officer of the watch:

1. All ships irrespective of size or position in relation to the vessel on which he is sailing.
2. All navigation marks or lights.
3. All floating objects.
4. Any sightings of ice, no matter in what form.
5. Sandbanks or prominent navigational features.
6. Derelicts and any other hazard considered dangerous to navigation.
7. The malfunction of the ship's lights, and their correct functioning at hourly intervals.

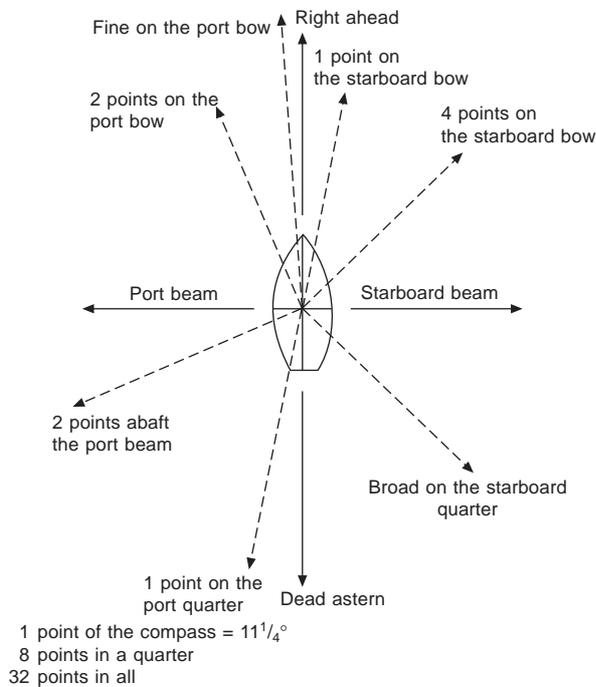


Figure 1.1 Field of view of the lookout.



3. Primary action of the Officer of the Watch is to maintain a continuous and effective lookout.

The lookout is also obliged to remain at his position until correctly relieved of his duties. On being relieved, he should acquaint his relief with relevant information concerning the items he has reported.

The lookout has a very responsible job and his duties must never be taken lightly. Rule 2 of the Regulations for Preventing Collisions at Sea states, 'Nothing in these Rules shall exonerate any vessel, or the owner, Master or crew thereof, from the consequence of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case', and Rule 5, 'Every vessel shall at all times maintain a proper lookout by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision'.

DUTIES OF THE HELMSMAN

The function of the 'helmsman' is to steer the vessel when it is not engaged on automatic pilot. On large passenger vessels the steering duty is normally carried out by the 'quartermaster' and the terms helmsman and quartermaster are both in common use in all merchant vessels. The duty can be tedious and tiring and regular reliefs are employed to maintain efficiency, since the responsibility for the safe passage of the vessel lies in the hands of the man steering.

A helmsman taking the wheel should come on duty earlier rather than later. It is one duty in which punctuality is always expected. At the change-over the course being steered should always be repeated out loud, from one man to another, in order to allow all personnel on the bridge to be aware of the course being steered. Once the wheel has been relieved, the helmsman whose duty has finished should report the course to the officer of the watch, who will repeat it in acknowledgment.

It is common practice when handing over the wheel to a relief to advise on the amount of 'helm' that the vessel is carrying in order to maintain her course reasonably steady. Such information can enable the relief to avoid excessive helm movement while keeping a steady course.

Although an old-fashioned custom which has largely dropped out of practice with the advent of the 'gyro compass' and 'reflector units', it was normal procedure for the helmsman to remove his knife and spike and any other metal about his person which might have affected the magnetic compass. He would at the same time remove any lanyard or loose fitting clothing which could possibly catch the spokes of the wheel when turning.

Before sailing, the steering gear should be tested, under the supervision of the duty officer, by putting the helm hard over to both port and starboard and holding the pressure in both positions, so that the rudder indicator will show the extent of movement in response to the helm.

Pilot Wheels

When a vessel is navigating in coastal waters, a pilot is generally employed and manual steering is used. The helmsman should take orders for the wheel movements from the pilot and repeat each order, word for word, back to the pilot before executing the movement. The man at the wheel should bear in mind that the pilot is an adviser to the Master and his representative (OOW), and at any time the Master or the officer of the watch may countermand the orders of the pilot.

DUTIES OF THE STANDBY MAN

These are numerous, depending on the time of day, the ship's position, and possibly the weather. In whatever situation the vessel finds herself, the function of the standby watchman is to back up the efficient running of the watch at sea (see Table 1.2). During daylight hours it is normal practice for this standby duty to be carried out in or around the navigational bridge area, where the officer of the watch can easily contact the duty man if required. There are often plenty of odd maintenance jobs to be carried out in this area, and normal working within earshot of the bridge helps to fulfil both requirements.

However, the main duties of the standby man are as follows:

- (a) To call the next duty watch in ample time to relieve watchkeepers.
- (b) To double up as additional lookout in the advent of poor visibility.
- (c) To rig and display or strike flag signals as required.
- (d) To carry out normal deck duties throughout the watch period, e.g. rig pilot ladders, stream logs, check cargo lashings, renew faulty navigation lights etc.

To summarise standby duty, one might say a 'jack of all trades', to be held in readiness for the unexpected incident. He is often in great demand to assist the OOW when approaching a port after a sea passage or when leaving a port at the start of a deep-sea passage.

TABLE 1.1 Example of helm orders

<i>Order (by OOW, Pilot or Master)</i>	<i>Helmsman's reply</i>	<i>Helmsman's actions</i>	<i>Helmsman's final report</i>
Starboard twenty degrees	Starboard twenty, sir	Turns the wheel until twenty degrees to starboard is shown by the rudder indicator	Twenty degrees of starboard helm 'on', sir
Midships	Midships, sir	Returns the wheel to the midships position. Checks that rudder indicator shows midships	Wheel amidships, sir
Hard a-port	Hard a-port, sir	Turns the wheel as far to port as it will go. Checks that rudder indicator shows maximum port helm	Wheel hard a-port, sir
Ease the wheel to port ten degrees	Ease the wheel to port ten degrees, sir	Allows the wheel to return towards the midships position, but retains ten degrees of port helm as shown by rudder indicator	Wheel eased to port ten degrees, sir
Check her (should be understood to mean, check the swing of the vessel)	Check her, sir	Turns the wheel against the swing of the vessel, up to approx. ten degrees of opposing helm being applied to reduce the rate of swing. Eases the wheel back to the midships position once the vessel stops swinging	
Steady	Steady, sir	Observes compass heading, or land reference point, and steadies the ship's head in/on that heading. Applies helm as required in order to maintain a steady course	Steady on course, X, Y, Z (or whatever the heading happens to be)

The supervising officer may, in addition, use the following phrases:

'*How is your head?*', a question as to the ship's compass heading.

'*Alter course to . . .*', ordering the helmsman to apply helm to change the ship's course to whatever is stated.

'*State when the vessel stops steering*', or when vessel no longer responds to helm movement because she has reduced her way, i.e. helm hard a-port and the vessel paying off to starboard.

'*Finished with the wheel*', when the helmsman is no longer required. The wheel is returned to midships and the helmsman can stand down.

TABLE 1.2 Example of four-hour watch operated by three men under supervision of OOW

MASTER OFFICER OF THE WATCH				
	1st hour	2nd hour	3rd hour	4th hour
Man A	First wheel (1st hour)	Standby	First wheel (2nd hour)	Lookout
Man B	Lookout	Second wheel (1st hour)	Standby	Second wheel (2nd hour)
Man C	Standby	Lookout	Lookout	Standby

The two men A and B each take two hours of the watch in steering duty. Each man has one hour standby duty with one hour lookout duty. Man C, known as the farmer, has no duty at the wheel but has two hours lookout duty and two hours of standby duty. In this manner the full four hours of wheel, lookout and standby are equally distributed between the three men. Rotation between first wheel (A), second wheel (B) and the farmer (C) ensures a fair allocation between all concerned.

OFFICIAL PUBLICATIONS

British merchant vessels are obliged by law to carry certain marine publications of the following nature in addition to sufficient navigational charts for the intended journey:

1. *Weekly Notices to Mariners,*
2. *Annual Summary of Admiralty Notices to Mariners,*
- 3a. *Marine Shipping Notices,*
- 3b. *Marine Information Notices,*
- 3c. *Marine Guidance Notices,*
4. *Mariners Handbook,*
5. *Admiralty List of Radio Signals,*
6. *Admiralty List of Lights,*
7. *Admiralty Sailing Directions,*
8. *Admiralty Tide Tables,*
9. *Nautical Almanac,*
10. *Nautical Tables,*
11. *Oil Record Book,*
12. *International Code of Signals,*
13. *Tidal Stream Atlas,*
14. *Code of Safe Working Practice,*
15. *IMDG Code,*

together with the operating manuals for all the navigational aids carried aboard the vessel.

In addition to the above, a well found ship would normally carry such publications as:

A copy of the Regulations for the Prevention of Collision at Sea,

A copy of Chart Abbreviations (No. 5011),
 IAMSAR Manual
 A copy of Ship Routeing and Traffic Separation Schemes,
 A Ship Master's Medical Guide,
 Stability Information Booklet,
 Relevant Statutory Instruments,
 and if relevant to the trade,
 Code of Safe Working Practice for Bulk Cargoes,
 Manual on the Avoidance of Oil Pollution,
 Tanker Safety Guide.

Other countries, especially those which comply with IMO conventions, have similar rules for the carriage of official publications. The only difference is that their titles may differ from the British ones.

Official Publications in Detail

Weekly Notices to Mariners

These are published by the Hydrographic Department of the Admiralty in booklet form. They contain an index to all the navigational corrections included in the booklet for that week, together with temporary (T) and preliminary (P) notices regarding navigational corrections. At the end of the booklet there are sections giving corrections to the *Admiralty List of Radio Signals*, and the *Admiralty List of Lights*. Information regarding new charts, new editions, and large and small corrections to charts are all included in the weekly list.

Annual Summary of Admiralty Notices to Mariners

This publication, is issued annually by the Hydrographic Department of the Admiralty. The notices contain information on such items as tide table corrections, list of agents for charts, radio message procedures, search and rescue operational details, firing and practice areas, submarine information, coastal radio warning stations, minelaying operations etc., ocean weather ship details, and navigational warnings. The *Annual Summary* and the *Weekly Notices to Mariners*, are obtainable from any of the mercantile marine offices, chart agents and custom offices.

Merchant Shipping Notices ('M' Notices)

These are published by the Marine Safety Agency and from 1997 known and titled as MSN's. They convey mandatory information which must be complied with under United Kingdom law. They amplify and expand on Statutory instruments. In addition, Marine Guidance Notes (MGNs) will be issued regarding specific topic areas, e.g. SOLAS, MARPOL etc.,' also Marine Information Notes (MINs) will be issued aimed at training establishments, equipment manufacturers etc. These will be published periodically and will also carry a self cancellation date.

NB. Each of the above notices will be pre-fixed by:
 (M) for Merchant Vessels
 (N) for Fishing Vessels
 (M+F) for both Merchant and Fishing Vessels.

Mariners Handbook

This handbook was first published in 1962 by the Hydrographer of the Royal Navy. It has since been reissued seven times, the last time in 1999. The *Handbook* is a reference book for mariners, giving information with regard to the following: charts and publications, the use of navigational aids, navigational hazards, natural conditions pertinent to weather, ice navigation and various tables of conversion factors.

Admiralty List of Radio Signals

These comprise eight volumes published by the Admiralty which contain details of individual radio stations and the services they provide, and information with regard to radio procedures, together with extracts of regulations governing transmission and reception of radio signals. The volumes cover all areas and provide information to operators regarding navigational warnings, time signals, medical advice, weather bulletins, satellite information and distress procedures.

Admiralty List of Lights

This is a publication in several volumes which lists the characteristics of all navigation lights and beacons. The lights are geographically listed to allow a prudent navigator to achieve continuity and easy comparison from the coastline against the listing. Information on each light includes the position of the light, the name of the light, its range and any flashing characteristic.

Admiralty Sailing Directions

Often referred to as 'Pilot Books', covering the whole world, they are published by the Admiralty in over 70 volumes. Each volume provides the mariner with general information and local knowledge of the area in which he intends to navigate. Items are covered in detail including port facilities, navigational hazards regarding port entry, systems of buoyage, coastline views and chart information.

Admiralty Tide Tables

Published by the Hydrographic Department of the Navy, these are tidal predictions for all 'standard' and 'secondary' ports. They are published in three volumes:

Volume I, covers European waters, including the Mediterranean.

Volume II, covers the Indian and Atlantic Oceans.

Volume III, covers the Pacific Ocean and adjacent seas.

The tables provide the time and the heights of high and low waters for the 'standard' port on a daily basis. In the second part of the volumes the details for 'secondary' ports can be calculated by making minor adjustment to the heights and times of tides at the nearest 'standard' port.

Nautical Almanac

This is a book of information relating to the sun, planets, moon and stars, published jointly by HM Nautical Almanac Office and the US Naval Observatory. The listing provides information with regard to Greenwich hour angle, meridian passage, sidereal hour angle etc. of celestial bodies. The listed information is required in the calculations made to ascertain the ship's position by observing heavenly bodies.

There are a number of publishers of nautical almanacs at present in the commercial field. The almanacs are published annually and should be collected well in advance for vessels engaged on long voyages which may run into the following year.

Nautical Tables

Every vessel is obliged to carry a set of these tables in order to carry out the basic navigational functions. Each set will contain computation tables of logarithms, traverse tables, square roots etc. together with tables for celestial navigation: A, B, and C tables, amplitude corrections, total correction tables etc. Additional tables cover coastal navigation, day's run, radar range, distance by vertical angle etc.

Several publishers are engaged in the distribution of nautical tables. The most popular are probably *Norie's Nautical Tables* and *Burtons Nautical Tables*.

Oil Record Book

This book's purpose is to record all oil movements aboard the vessel. It is carried by tanker vessels and vessels other than tankers. All entries should bear the signature of the Master of the vessel, together with those of officers concerned in the movement of oils or oily waste. A copy of the entries made into the oil record book for a non-tanker type vessel is given in Table 1.3.

International Code of Signals

Published by Her Majesty's Stationery Office, it is used for coding and decoding signals made by international signal flags. It also contains information on methods of marine communication and procedures for their execution. (See Part One, Chapter 9, 'Communications'.)

Tidal Stream Atlas

This contains detailed plans of the British Isles and other selected areas showing the state of the tide at hourly intervals either side of high water. Indication of the tidal flow is shown by arrows referring to times and state of tide at a major port, e.g. 'Dover, High Water'. By comparing the ship's position and the time to the time of high water at a particular port, the navigator can ascertain the state of the tide in relation to the ship.

TABLE 1.3 Entries in oil record book for ships other than tankers

(a) *Ballasting or cleaning of bunker fuel tanks*

1. Identity of tank(s) ballasted
2. Whether cleaned since last containing oil and if not, type of oil previously carried
3. Date and position of ship at start of cleaning
4. Date and position of ship at start of ballasting

(b) *Discharge of dirty ballast or cleaning water from tanks referred to under (a)*

5. Identity of tank(s)
6. Date and position of ship at start of discharge
7. Date and position of ship at finish of discharge
8. Ship's speed(s) during discharge
9. Method of discharge (state whether separator was used)
10. Quantity discharged

Signature of officer or officers in charge of the operations and date.
Signature of Master and date.

(c) *Disposal of residues*

11. Quantity of residue retained on board
12. Methods of disposal of residue:
 - (a) reception facilities
 - (b) mixed with next bunkering
 - (c) transferred to another (other) tank(s)
13. Date and port of disposal of residue*

Signature of officer or officers in charge of the operations and date.
Signature of Master and date.

(d) *Discharge of oily bilge water which has accumulated in machinery spaces whilst in port*

14. Port
15. Duration of stay
16. Quantity disposed
17. Date and place of disposal
18. Method of disposal (state whether separator was used)

(e) *Routine discharge at sea of oily bilge water from machinery spaces**

19. Frequency of discharge and method of disposal (state whether or not a separator was used)*†

Signature of officer or officers in charge of the operations and date.
Signature of Master and date.

(f) *Accidental or other exceptional discharge of oil.*

20. Date and time of occurrence
21. Place or position of ship at time of occurrence
22. Approximate quantity and type of oil
23. Circumstances of discharge or escape and general remarks

Signature of officer or officers reporting the occurrence and date.
Signature of Master and date.

* In accordance with regulations such discharges need not be entered into this book if entered in the engine room log book.

† Where pumps start automatically and discharge through a separator at all times, it will be sufficient to enter each day, 'Automatic discharge from bilges through separator'.

Code of Safe Working Practice

A recent publication by Her Majesty's Stationery Office on behalf of the Maritime and Coastguard Agency, this details safe working practice for seamen in all departments of the ship. It covers deck work, engine room practice, electrical apparatus etc. together with working practices in and around the galley and catering department.

IMDG Code

Mariners are guided by rules and recommendations regarding the carriage of dangerous goods at sea, and these rules and recommendations are contained in what is known as *The International Maritime Dangerous Goods (IMDG) Code*. This publication has now replaced what was previously known as *The Blue Book*. It is published by the IMO and is directly concerned with the recommendations relevant to the carriage of dangerous substances. It specifies in detail the method of stowage and packaging of dangerous cargoes.

It is contained in five volumes and provides relevant information on the required documentation and respective class of cargoes.

Shippers are required under the Merchant Shipping (Dangerous Goods) Rules to provide a certificate stating that the goods are properly marked, labelled and packaged in accordance with the rules. The goods are classified as follows:

- Class 1. Explosives.
- Class 2. Flammable gases, poisonous gases, or compressed, liquefied or dissolved gases which are neither flammable nor poisonous.
- Class 3. Flammable liquids sub-divided into three categories:
 - 3.1 Low flashpoint group of liquids having a flashpoint below -18°C (0°F) closed cup test, or having a low flashpoint in combination with some dangerous property other than flammability.
 - 3.2 Intermediate flashpoint group of liquids having a flashpoint of -18°C (0°F) up to but not including 23°C (73°F) closed cup test.
 - 3.3 High flashpoint group liquids having a flashpoint of 23°C (73°F) up to and including 61°C (141°F) closed cup test.
- Class 4.
 - 4.1 Flammable solids.
 - 4.2 Flammable solids or substances liable to spontaneous combustion.
 - 4.3 Flammable solids or substances which in contact with water emit flammable gases.
- Class 5.
 - 5.1 Oxidising substances.
 - 5.2 Organic peroxides.
- Class 6.
 - 6.1 Poisonous (toxic) substances.
 - 6.2 Infectious substances.
- Class 7. Radioactive substances.
- Class 8. Corrosives.
- Class 9. Miscellaneous dangerous substances, that is any other sub-stance

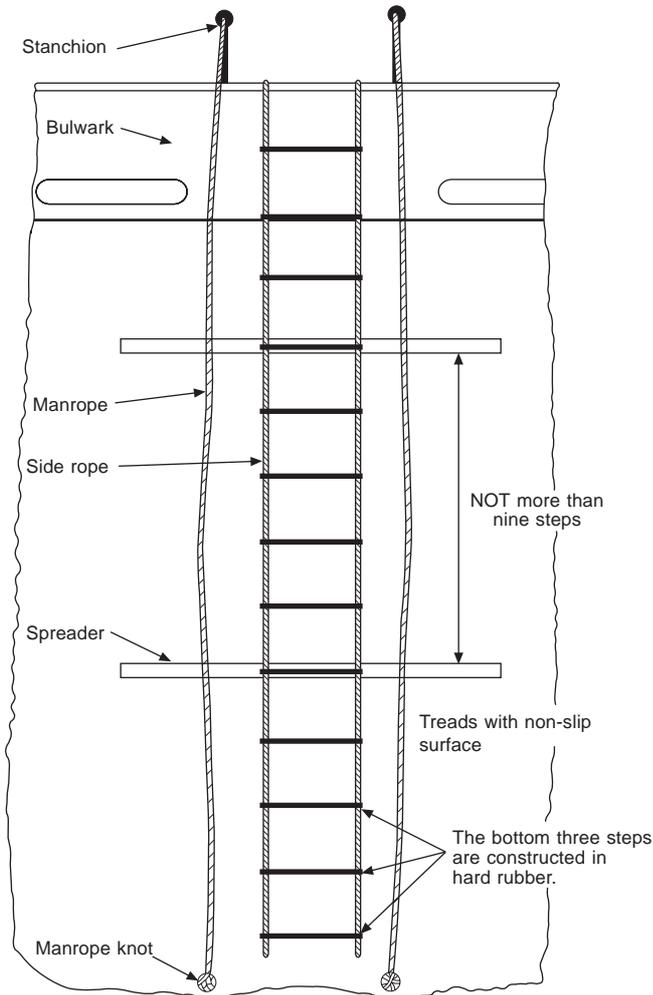


Figure 1.2 Pilot ladder.

which experience has shown, or may show, to be of such a dangerous character that this class should apply to it.

RIGGING PILOT LADDERS

Each pilot ladder shall be suitable for the purpose of enabling a pilot to embark and disembark safely. Such ladders must be used only by officials and other persons while a ship is arriving or leaving a port and for the disembarkation and embarkation of pilots. Every pilot ladder must be secured in a position clear of any possible discharge from the ship and so that the steps rest firmly against the ship's side (Figure 1.2), providing the pilot convenient access to the vessel after climbing not less than 5 ft (1.5 m) nor more than 30 ft (9 m).

A single length of ladder should be used, and it should be capable of reaching the water from the point of access to the ship when the ship is in the unloaded condition and in normal trim with no list. Whenever the distance to the water exceeds 30 ft (9 m), then access to the vessel

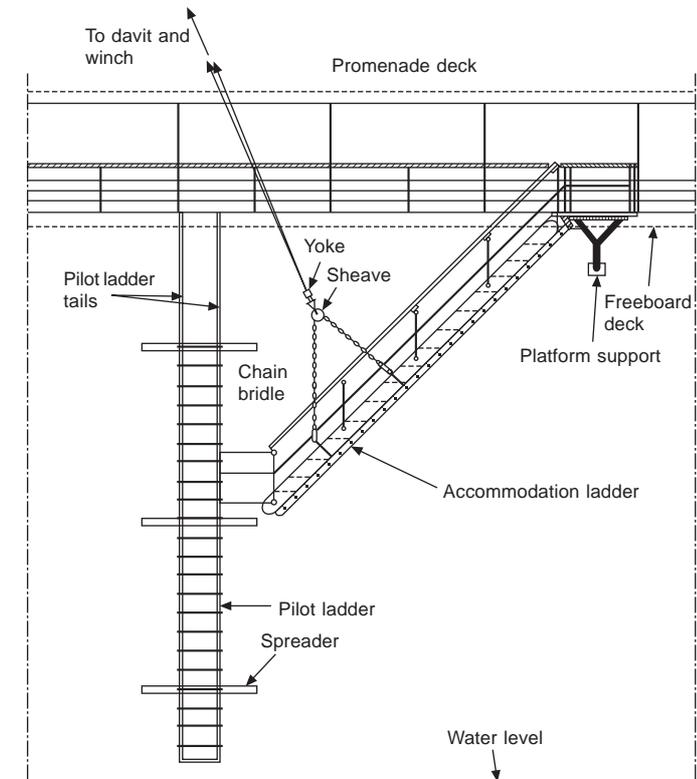


Figure 1.3 Combined rigging of accommodation and pilot ladders.

must be by means of an accommodation ladder or other equally safe means (Figure 1.3).

The treads of the ladder must be made of a hard wood such as ash, oak, elm or teak. Each step must be made from a piece free of knots, having a non-slip surface; and must be not less than 480 mm long, 115 mm wide and 25 mm in depth. The steps should be spaced not less than 300 mm nor more than 380 mm apart, and individually secured in such a manner that they will remain horizontal. The four lower steps may be constructed in rubber or other suitable material of sufficient strength and similar character. No pilot ladder must have more than two replacement steps secured in a different manner from the original method of securing, and these must be secured in place by the original method as soon as possible.

The side ropes of the ladder must consist of manilla rope 18 mm in diameter. Each rope must be continuous without joins and should be left uncovered. Manropes of not less than 20 mm in diameter should be secured to the ship, and a safety line kept ready for use if required.

Hard wood battens (spreaders or anti-twist battens) between 1800 and 2000 mm long must be provided at such intervals as will prevent the pilot ladder from twisting. They must be so fixed that the lowest batten comes no lower than the fifth step from the bottom, and the interval between battens must not be more than nine steps. Each batten must be made of ash, oak or similar material, free of knots.

Safe access must be provided between the pilot ladder and the vessel. Gateway or hand holds are suitable safety measures.

The bulwark ladder must be hooked on to the bulwark in a secure manner. It must be fitted with two handhold stanchions at the point of boarding. The stanchions should be not less than 700 mm nor more than 800 mm apart, be rigid in their construction, and extend not less than 1200 mm above the top of the bulwark (Figure 1.4).

A light must be provided at night, and a lifebuoy equipped with a self-igniting light kept ready for immediate use.

MECHANICAL PILOT HOISTS

Mechanical pilot hoists generally consist of three main parts:

1. A mechanical powered appliance together with means of safe passage from the hoist to the deck and vice-versa.
2. Two separate falls (steel wire rope).
3. A ladder consisting of two parts:
 - (a) a rigid upper part for the transportation of the pilot upwards or downwards,
 - (b) a lower section consisting of a short length of pilot ladder which enables the pilot to climb from the pilot launch to the upper part of the hoist and vice-versa.

Mechanical Powered Appliance

The source of power may be electrical, hydraulic or pneumatic. The winch arrangement should incorporate some form of braking system capable of supporting the working load in the event of power failure, and be equipped with crank handles for manual operation at a reasonable speed. These crank handles, when inserted, automatically cut off the power supply.

All hoists are fitted with emergency stop arrangements and automatic power cut-outs in the event of the hoist becoming jammed. Should the hoist be of a pneumatic type, the power cut-outs may be omitted, provided that the maximum torque available from the air motor cannot result in the overloading of the gear.

Pilot hoists should be securely attached to the ship's structure with safe means of access from the hoist to the ship and vice-versa. The platform arrangement should be securely guarded by handrails. The wire falls must be wound evenly on to the winch drums and the winch controls clearly marked to indicate the 'hoist', 'stop' and 'lower' positions.

The powered appliance must be capable of hoisting or lowering at a speed of between 15 and 30 m per minute. If it is electrically powered, the voltage should not be in excess of 25 volts.

NB. 'M' Notice No. 1716 recommends that the large wooden distance pieces should not be used to secure the steps with the side ropes, as they are liable to obstruct the hands of the pilot. However, small winnets are acceptable.

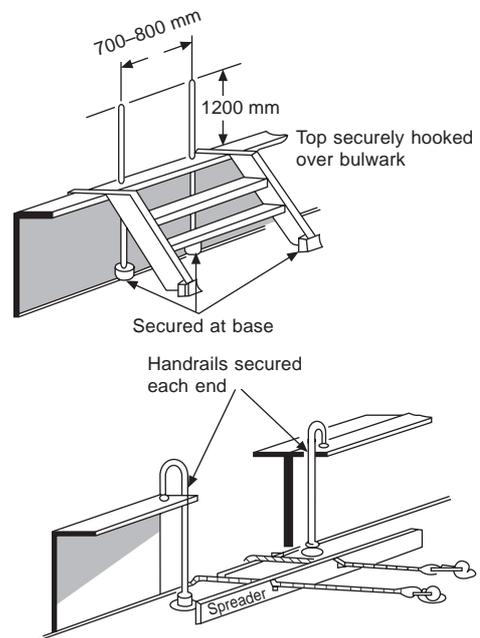


Figure 1.4 Access to the deck from pilot ladders.

Falls

The two separate flexible steel wire rope falls should be resistant to corrosion in a salt-laden atmosphere. They should be securely attached to the winch drums and the ladder by fittings capable of withstanding a proof load of not less than 2.2 times the load on such fittings. The length of the falls should be sufficient to allow at least three turns to be retained on the winch drum when the hoist is in the lowest position, at all levels of freeboard.

Ladder Sections

The rigid section should be not less than 2.5 m in length and arranged so that the pilot may take up a safe position while being hoisted. It should be provided with adequate means of communication between the pilot and the hoist operator, together with an emergency stop control within easy reach of the pilot.

The section should be fitted at the lower end with a spreader not less than 1.8 m in length. The ends of the spreader should be provided with rollers which will allow the section to roll freely on the ship's side during the operation of embarking and disembarking pilots. A sufficient number of steps with non-skid surfaces should be included in the section to facilitate safe and easy access to the deck of the vessel.

The section should also be provided with suitable handholds, which will protect operators' hands from extreme temperatures and provide a safe secure hold. In addition, it needs an effective guard ring, well padded to support the pilot without hampering his movements.

The flexible section consists of a pilot ladder length of eight steps. Manufactured in hard wood, it should be free of knots like the conventional pilot ladder, and of the same size.

Both the rigid and the flexible sections should be in the same vertical line, be of the same width and placed as near to the ship's side as practicable. Both sections should be so secured that the handholds are also aligned as closely as possible.

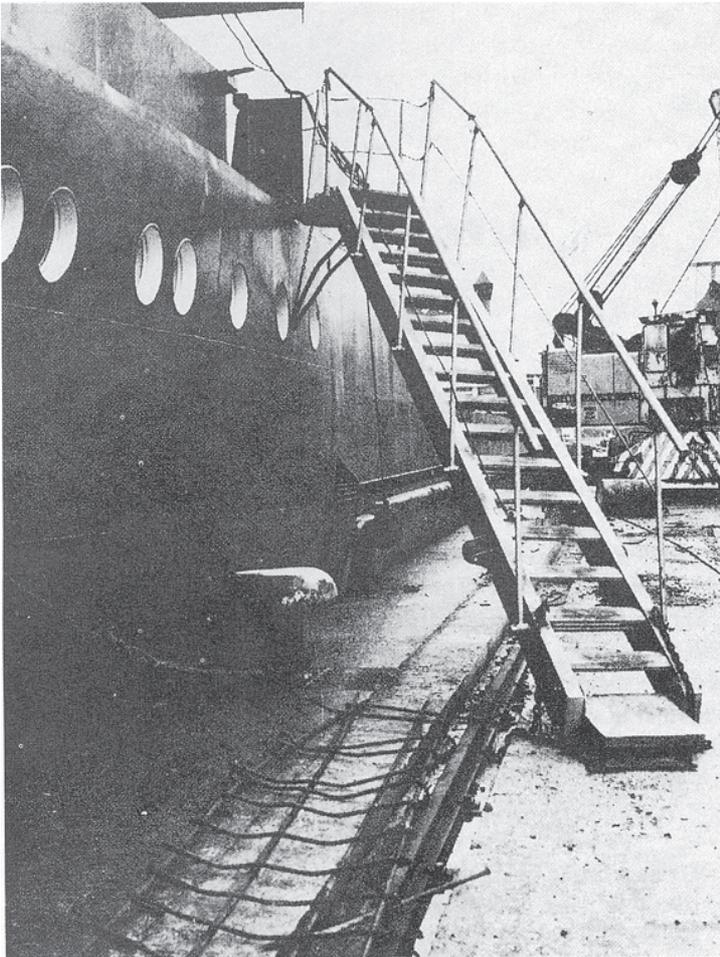
Testing of New Hoists

All new pilot hoist systems are subjected to an overload test of 2.2 times the working load. During the test the load should be lowered a distance of not less than 5 m, the weight of each person being taken as 150 kg.

After installation has been completed, a 10 per cent overload test should be carried out to check securing attachments. Regular test rigging and inspection should be carried out by ships' personnel at intervals not exceeding six months and a record of these checks maintained by the Master in the ship's log. Subsequent examinations of the hoists, under working conditions, should be made for each survey for the vessel's Safety Equipment Certificate.

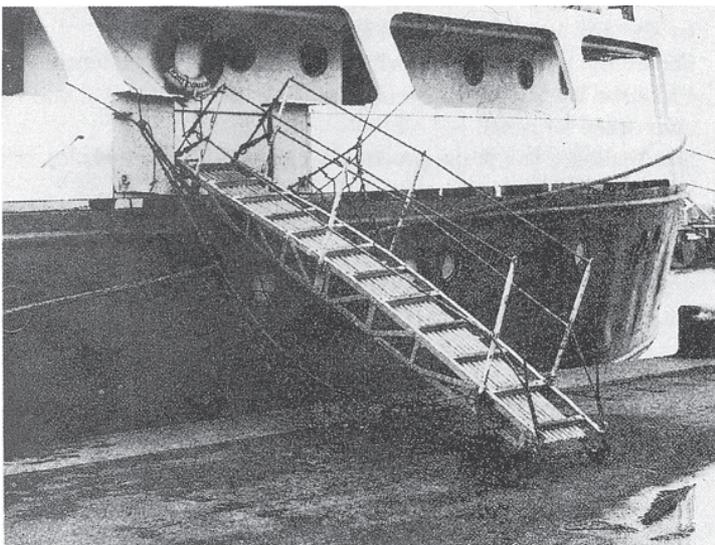
Rigging and Operational Aspects

Before use, the rigging of the hoist should be supervised by a responsible



4. Accommodation ladder, seen in the turned out position and slewed on to the quayside.

Bridle and yoke having been disconnected, the weight of the ladder is taken by the quay and the 'Y' bracket from the underside of the turntable, whence the upper platform leads into the ship's side.



5. Department of Trade gangway, rigged at right-angles to the fore and aft line, with gangway net rigged, lifebelt readily accessible, and bulwark gateway open.

officer and the system tested to the satisfaction of the operator before embarking or disembarking pilots. The operational area should be adequately lit and a lifebuoy should be on hand for immediate use.

A conventional pilot ladder should be rigged adjacent to the hoist for use by the pilot should he so prefer. This pilot ladder should be fully rigged during the operation of the hoist in such a manner as to be accessible to the pilot from any point on the mechanical hoist during the period of travel.

Protective stowage for pilot hoists is required, especially in cold weather, when ice formation may cause damage to the equipment. Bearing this fact in mind, the portable hoist should not be rigged until its use is imminent.

NB. Additional reference, see 'M' Notice regarding the rigging and operation of pilot ladders and points.

SHIP TO SHORE TRANSIT

Once the ship has arrived in port accommodation ladders and/or gangways must be rigged (see Plates 4 and 5).

SPEED AND DEPTH



PATENT ROTATOR LOG

This consists of a rotator manufactured in phosphor bronze, which is towed astern of the vessel. The towline used to be sennet laid hemp, but this has been largely superseded by man-made fibre line of an 8 mm approximate size. The number of rotations is recorded by a clock mechanism secured to the after taff rail of the vessel. For many years it was normal to stream the log via a midships boom arrangement, but this method was abandoned with the advent of the electric 'Trident' register, which allowed recording repeaters to be positioned on the Bridge.

Streaming the Log

1. Collect the log clock, governor, log line and rotator from the Bridge (or other place of stowage).
2. Secure the log clock into the 'shoe' on the after taffrail, on the weather quarter. On this quarter the rotator will not become fouled by garbage usually thrown to leeward.
3. Secure the governor to the clock by means of the Englefield clip.
4. Flake the log line up and down the deck to ensure that it will run clear when streamed.
5. Secure the log line to the governor via a second Englefield clip, or as indicated in Figure 2.1.
6. Pass the other bare end of the line through the neck of the frog and out through the centre. Tie a figure eight knot in the end of the line then pull the line from the point of entry into the frog, so jamming the figure eight knot inside the neck of the frog.
7. Pay the log line overside in the form of a 'U' bight, holding on to the rotator until all the line is paid out.
8. Throw the rotator into the sea at right-angles to the fore and aft line.
9. The forward motion of the vessel will arc the line outwards until it becomes fully stretched astern. The seafarer should ease the strain on the log clock as the weight is taken up on the line.

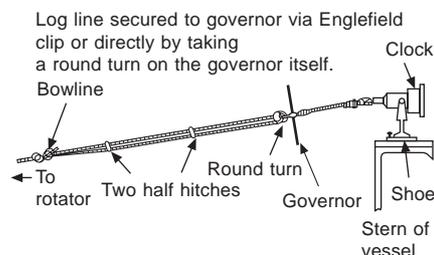


Figure 2.1 Securing patent log.

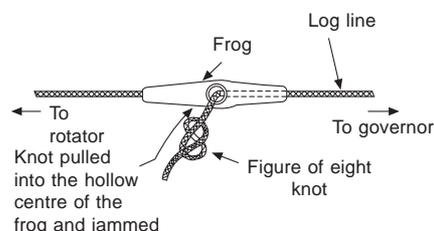


Figure 2.2 Securing logline to frog.

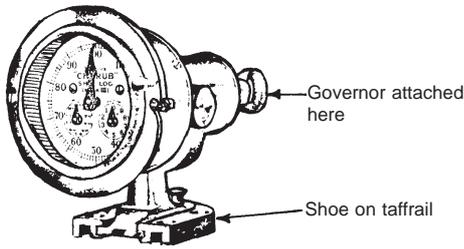


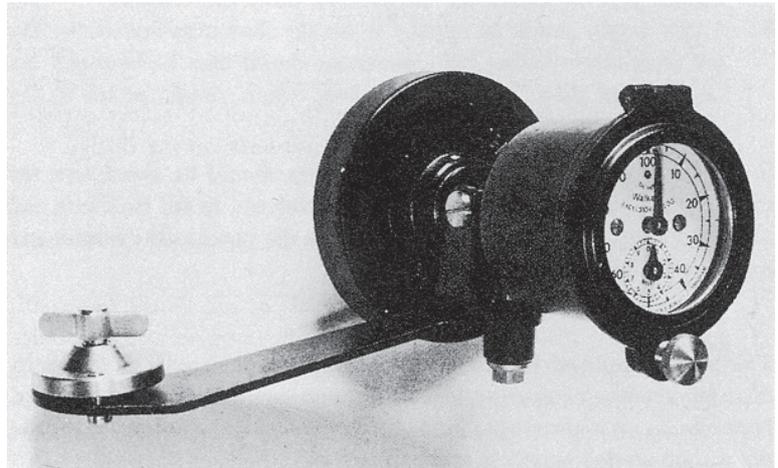
Figure 2.3 Log clock.

10. Once the rotator is fully outstretched, spin the governor to set in motion. Ensure dials are set to zero on the log clock.
11. Care should be taken throughout the operation to ensure that the vanes of the rotator are not damaged on deck or against the ship sides.

Many logs are fitted with an electric transmission to a repeater in the chart room. If fitted, this should be plugged in, and the bridge should always be informed that the log is streamed.

Clock

The clock, which is attached to the vessel, converts the turns of the rotator into distance, like the distance recorder in a car, the rotation of the log line being geared down so that nautical miles are registered. There are three dials on the face, one to record tenths of a mile, one to record miles, and one to record hundreds of miles. The clock is usually made of brass or other non-rusting metal and is fitted with an eye for an Englefield clip to facilitate attachment of the governor (see Figure 2.3 and Plate 6).



6. Walker's Excelsior log clock.

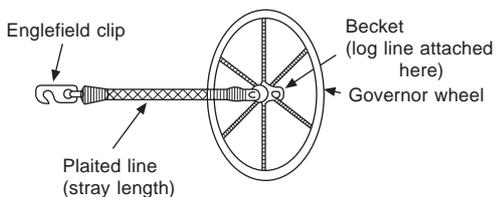


Figure 2.4 Governor.

Governor

The purpose of the governor-wheel (Figure 2.4) is to provide steadiness to the inner spindle of the log clock as it revolves due to the action of the rotator. The governor-wheel is usually made of a non-rusting metal and has a short stray length seized at the central point. A becket is fitted on the opposing side to receive the log line, with or without an Englefield clip.

Frog and Rotator

The frog and the rotator (Figure 2.5) are made of either brass or phosphor

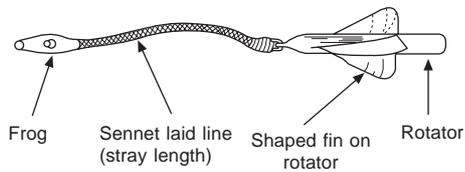


Figure 2.5 Frog and rotator.

bronze to resist the corrosive action of salt water. The rotator is a hollow tube having curved vanes attached to the sides and seized to a hollow frog (often referred to as a bottle) by a short length of sennet laid line (stray length). The opposite end of the frog receives the log line and is secured in the manner shown in Figure 2.2.

To 'Hand' the Log (heaving the log back aboard)

1. Disconnect the bridge connection to the bridge repeater.
2. Stop the governor from rotating and bring in a little of the log line by hand.
3. Unclip the Englefield clip from the governor.
4. Continue to heave the log line inboard, taking the bare end to the opposite quarter of the vessel. Pay out the bare Englefield clip end as the rotator is heaved in.
5. Allow time for any kinks in the rope caused by the rotator to be 'turned out'. Heave in the line, coiling down left-handed.
6. A light grease should be applied to the log clock after removal of any salt crust on the casing. All equipment should then be returned to a safe stowage place, except for the line, which should be left to dry naturally.

When heaving the log back aboard, mariners should be aware that the rotator when breaking the surface has the tendency to fall back into and under the stern. This could cause damage to the vanes of the rotator and render it useless for future operation.

Rotator logs are now limited in use with the advent of various impeller and/or Doppler logs becoming the norm.

Length of Log Line

The length required for reasonable accuracy will vary; it is found by experience when comparing logged distance against observed distance. However, as an approximate guide for vessels with the following speeds, the recommended length is approximately:

- (a) 75 m to 95 m for speeds of about 12 knots.
- (b) 100 m to 125 m for speeds of about 15 knots.
- (c) 130 m to 160 m for speeds of about 20 knots.

The length of the log line will effectively change as a vessel changes her draught especially in high freeboard vessels when in ballast. To this end, small adjustments to the real length of line can be made if it is secured to the governor as indicated in Figure 2.1, one of the half hitches being removed to add length to the line or the half hitches spaced out to shorten the real length. In practice, it is normal to check the log against

observed positions and allow for the log reading fast or slow, in preference to continual adjustment of the length of line, although that is a simple process.

IMPELLER LOG

The impeller log may be considered an electric log, since its operation is all electrical, except for the mechanical rotation of the impeller. There are several designs in general use, but probably the most common is the 'Chernikeeff'.

The principle of operation is based on turning an impeller by a flow of water, the speed of rotation being proportional to the rate of flow past the impeller (turbine principle). As previously stated, designs vary, the two most popular being one with a ring magnet attached to the spindle

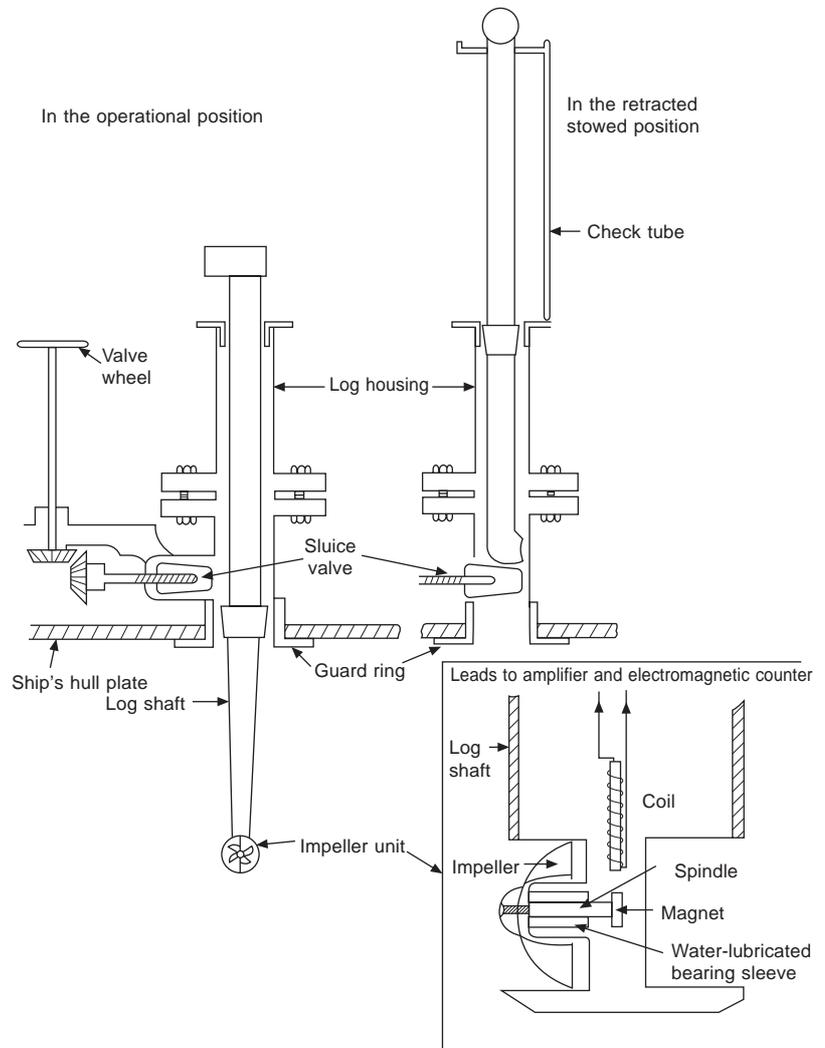


Figure 2.6 Impeller log.

and one with the magnet incorporated in the blades of the impeller. In either case a pick-up coil transmits the generated pulses via an amplifier to an electromagnetic counter. This signal is then displayed by a speed indicator and distance recorder.

Additional sensors will provide the opportunity for various repeaters to include a direct link to allow speed input into True Motion Radar. Operating power is normally 230/240 volts.

It is worth noting that the load on the impeller is negligible; consequently the slip, if any, on the impeller is minimal and can be ignored. The extended log, when in operation, projects approximately 14 in. (35 cm) below the ship's hull, usually from the engine room position. The log shaft should be housed in the stowed position for shallow water, drydocking etc. The sea valve sluice need only be closed if the log is to be removed for maintenance. However, it must be considered good seamanship practice to close the sluice each time the log is housed.

Performance of the log is in general considered to be very good, but obvious problems arise in dirty water areas with a muddy bottom and heavily polluted canals (see Figure 2.6).

HAND LEAD

The normal length of the hand lead line is about 25 fathoms, and the line used is 9 mm ($1\frac{1}{8}$ in.) untarred cable-laid hemp (left-hand lay). A rawhide becket attached to an eye splice in the end of the line secures the lead, the weight of which is 7–9 lb (3.2–4 kg) when operating from vessels moving at less than 6 knots.

From the eye splice, i.e. 'lead out', which has the extra safety factor of the length of the lead, or 'lead in', measured from the base of the lead, the markings are as follows:

- At 2 fathoms a piece of leather with two tails.
- At 3 fathoms a piece of leather with three tails.
- At 5 fathoms a piece of white linen.
- At 7 fathoms a piece of red bunting.
- At 10 fathoms a piece of leather with a hole in it (leather washer).
- At 13 fathoms a piece of blue serge.
- At 15 fathoms a piece of white linen.
- At 17 fathoms a piece of red bunting.
- At 20 fathoms a piece of cord with two knots.

Markings of metric hand lead line are as follows:

- 1 and 11 m – 1 strip of leather
- 2 and 12 m – 2 strips of leather
- 3 and 13 m – blue bunting
- 4 and 14 m – green and white bunting
- 5 and 15 m – white bunting
- 6 and 16 m – green bunting
- 7 and 17 m – red bunting
- 8 and 18 m – yellow bunting

- 9 and 19 m – red and white bunting
- 10 m – leather with a hole in it
- 20 m – leather with a hole and 2 strips of leather

The different materials indicating the various marks are distinctive to allow the leadsman to feel rather than see the difference during the hours of darkness. The intermediate whole fathom values, i.e. 1, 4, 6, 8, 9, 11, 12, 14, 16, 18 and 19 fathoms, are known as deeps.

The leadsman used to stand in the 'chains', from where he would take the cast and call up the sounding to the officer of the watch. The lead line is rarely used in this manner today, but the soundings are still occasionally called in a traditional manner of stating the actual number of fathoms last. For example,

- At 7 fathoms . . . 'by the mark seven'.
- At $7\frac{1}{4}$ fathoms . . . 'and a quarter seven'.
- At $7\frac{1}{2}$ fathoms . . . 'and a half seven'.
- At $7\frac{3}{4}$ fathoms . . . 'a quarter less eight'.
- At 8 fathoms . . . 'by the deep eight'.

Should the bottom not be reached, then 'No Bottom' is reported.

Constructing a New Line

Splice the eye into one end of the line, then soak and stretch the line, possibly by towing astern. Mark the line off when wet from measured distances marked off on deck, and tuck the fabrics of the marks through the lay of the line.

Benefit of the Lead

This is the term used to describe the length from the base of the lead to the eye splice. The actual distance is about 12 inches (30 cm) and is always 'beneficial' to the soundings, giving more water for the benefit of the ship.

Arming the Lead

This describes the action of placing tallow into the 'arming recess', found at the base of the lead. The purpose of the soft tallow is to act as a glue to obtain the nature of the sea bottom. If tallow is not available, a soft soap will be equally good. The information is passed to the Officer of the Watch with the depth of sounding. It allows an additional comparison with the charted information.

ECHO-SOUNDING

Principle of the Echo-sounder

The echo-sounding depth recorder emits a pulse of sound energy from a transmitter, and the time this pulse takes to reach the sea bed and be reflected back to the vessel is directly related to the distance. Speed of

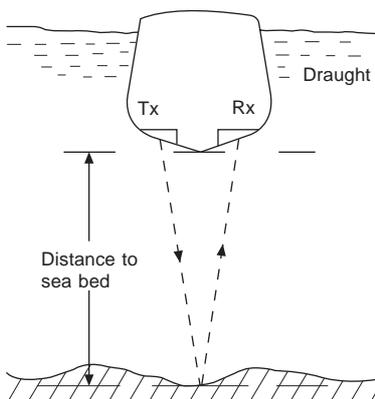


Figure 2.7 Principle of the echo-sounder.

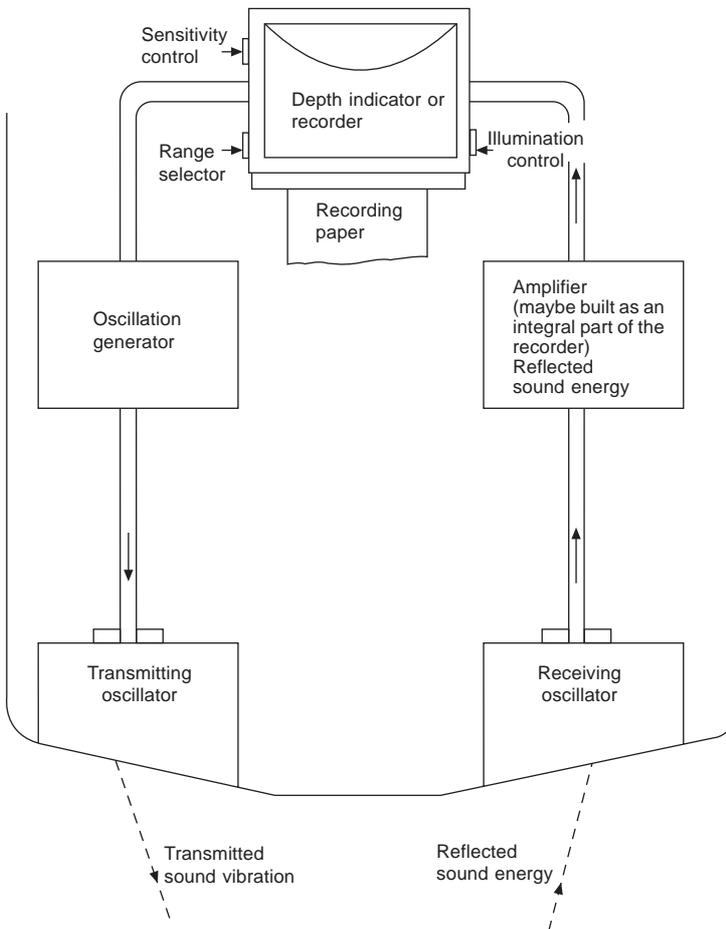


Figure 2.8 Echo-sounder.

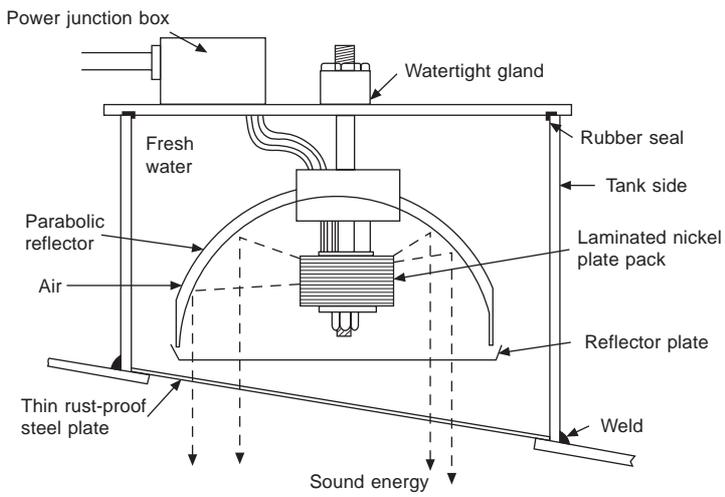


Figure 2.9 Echo-sounder's transmitting oscillator (magnetostriction type).

sound through water being the known value of 1500 metres per second (see Figures 2.7 to 2.9).

However, that value will vary with water temperature and salt content (salinity).

Let us work out an example:

Let the velocity of sound in water = v metres per second.

Let the time between transmission and reception of the pulse = t seconds.

Let the distance to the sea bed and back = $2s$ metres.

But the distance = speed \times time

$$\therefore 2s = v \times t$$

$$\therefore s = \frac{vt}{2} \text{ metres}$$

Therefore, s represents the depth of water under the vessel.

Possible Errors of Echo-sounding Equipment

1. *Differences of the velocity of propagation.* Owing to the differences of salinity and temperature encountered in various parts of the world, adjustment tables are available, published by the Admiralty.
2. *Transmission line error.* This is caused by the misalignment of the reference 'zero' on the scale. Reference 'zero' sets the timer of the recorder unit, and if it is not set at 'zero', then a false time and recording will be obtained.
3. *Pythagorean error.* This error is encountered with separated transducers rather than with the combined transmit/receive unit. The error is caused by the measuring of the 'slant distance' as opposed to the vertical distance under the keel.
4. *Aeration.* The presence of air in the water will affect the speed at which sound travels through it, since the velocity of sound through air is much less than that in water (330 m/s compared with 1500 m/s). The main causes of aeration are:
 - (a) Turbulence caused by having the rudder hard over.
 - (b) Having a light ship which is pitching heavily.
 - (c) Having sternway on the vessel.
 - (d) Having broken water over shoals.
 - (e) Entering an area where prevalent bad weather has left pockets of air bubbles over comparatively long periods.

Possible cures for the above include stopping or reducing the vessel's speed, and abrupt movement of the rudder either way, to sweep away formed bubbles.

False Echoes

False bottom echo

This may occur if the echo-sounder is incorrectly set in such a manner that in deep water a returning echo is received after the stylus has completed one revolution.

Multiple echoes

These are caused by the transmitted pulse being reflected several times between the sea bed and the water surface before its energy is dispersed. Such multiple reflection may cause multiple echoes to be recorded on the trace of the sounding machine. They can, however, be reduced in strength by decreasing the sensitivity control on the equipment.

Double echo

This type of echo is a double reflection of the transmitted pulse. It occurs when the energy is reflected from the sea bed and then reflected back from the surface of the water before being received by the transducer. A double echo is always weaker than the true echo, and can be expected to fade quickly with a reduction in the sensitivity of the equipment.

Other causes

Side echo may come from objects not directly under the keel of the vessel reflecting the sound energy, e.g. shoals of fish or concentrations of weed or kelp. There may be electrical faults or man-made noise in and around the hull. In addition, turbulence may be caused by the vessel herself, with or without interaction between the shore or other shipping.

Deep scattering layer

This is a level of several layers believed to consist of fish and plankton which will scatter and reflect sound energy. The layer has a tendency to move from as much as 450 m below the surface during the daylight hours to very near the surface at night. It becomes more noticeable during the day when the cloud cover is sparse than when sky is overcast.

MARINE INSTRUMENTS



SEXTANT

The sextant's purpose is to measure angles, either vertical or horizontal to obtain the necessary data to check the vessel's position. Latitude and longitude may be determined by a combination of sextant, chronometer and nautical almanac readings.

This precision instrument is based on the principle, enunciated by the First Law of Light, that when a ray of light is reflected from a plane mirror, then 'The angle of incidence of the ray equals the angle of reflection'. In the sextant a ray of light is reflected twice by two mirrors, the index and horizon mirrors, in the same plane. When a ray of light is reflected in this way by two plane mirrors, then the angle between the direction of the original ray and the direction of the final reflected ray is twice the angle between the mirrors (see Figures 3.1 and 3.2 and Plate 7a).

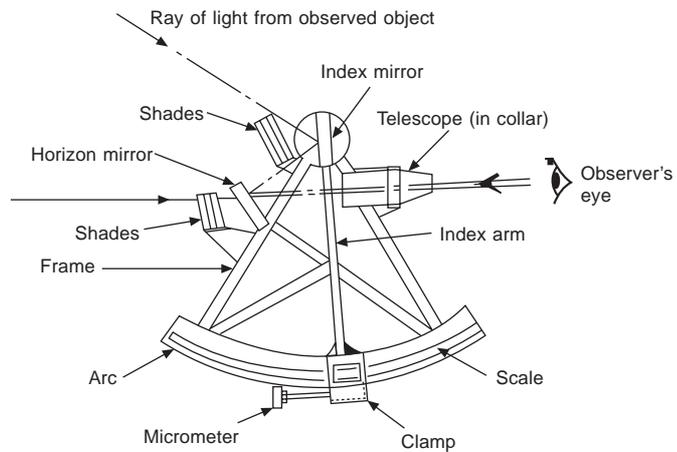


Figure 3.1 Sextant.

Principle of the Sextant

The principle of the sextant is based on the fact that twice the angle between the mirrors HAI must equal the angle between the initial and final directions of a ray of light which has undergone two reflections.

Proof

Let α represent the angle between the mirrors.
 Let \varnothing represent the angle between the initial and final directions of a ray of light.
 The required proof is:

$$2\alpha = \varnothing$$

Construction

Extend the ray of light from the object to intersect the reflected ray from the Horizon Mirror H at point L .

Proof of theory

- (i) The angle between the mirrors α is equal to the angle between the normals to the mirrors.
- (ii) In triangle HIK

$$\beta = \alpha + X$$

and $2\beta = 2\alpha + 2X$

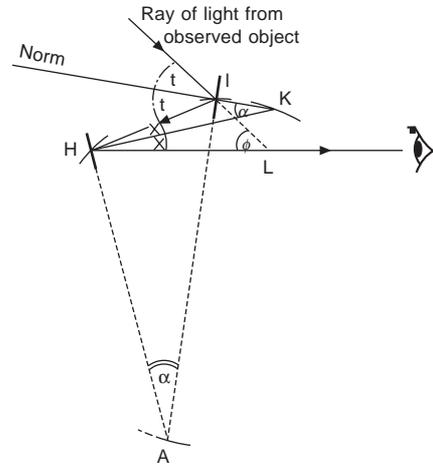
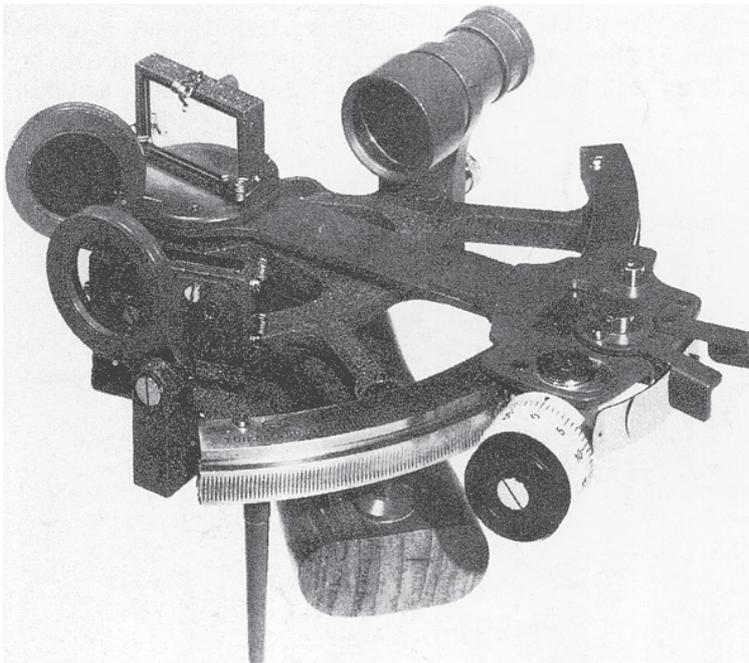


Figure 3.2 Principle of the sextant.



7a. Marine sextant.

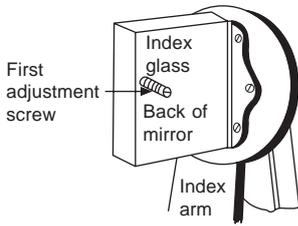


Figure 3.3 Adjustment screw on index mirror.

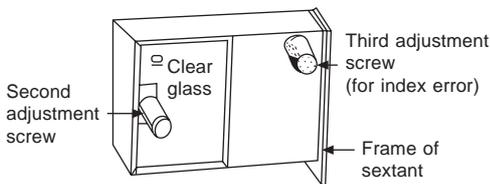


Figure 3.4 Adjustment screws on horizon mirror, seen from behind.



Figure 3.5 Images of true and reflected stars, showing side error.

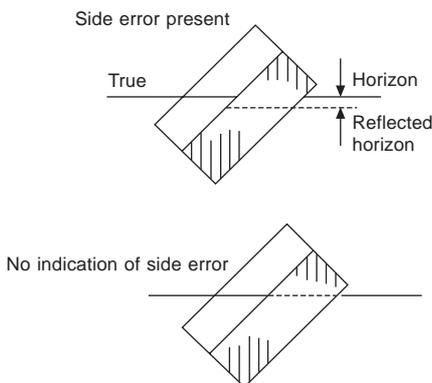


Figure 3.6 Indication of side error.

(iii) In triangle *HIL*

$$2\beta = \emptyset + 2X$$

therefore from equation (ii) and (iii)

$$2\alpha + 2X = \emptyset + 2X$$

and $2\alpha = \emptyset$

i.e. twice the angle between the mirrors is equal to the angle between the initial and final directions of a ray of light which has undergone two reflections in the same plane, by two plane mirrors.

Errors of the Marine Sextant

There are three main errors, which can quite easily be corrected by the mariner. A fourth error, for 'collimation', can also be corrected, with care and attention, but only to an older sextant where telescope collars are fitted with adjusting screws.

The first error, of *Perpendicularity*, is caused by the index mirror not being perpendicular to the plane of the instrument. To check if this error is present, clamp the index arm between a third and half way along the arc, remove the telescope, and look obliquely into the index mirror, observing the true and reflected arcs of the sextant. Hold the sextant horizontal, arc away from the body. If the true and reflected arcs are not in line with each other, then an error of perpendicularity must be considered to exist (Figure 3.3).

To correct the error, adjust the screw at the rear of the index mirror until the true and reflected arcs are brought together in line.

The second error, *side error*, is caused by the horizon mirror not being perpendicular to the plane of the instrument. There are two ways of checking if this error is present. The first is by observing a star. Hold the sextant in the vertical position with the index arm set at zero, and observe a second magnitude star through the telescope. If the true and reflected stars are side by side, then side error must be considered to exist (Figure 3.5). It is often the case when checking the instrument for side error that the true and reflected stars are coincident. If this is the case, a small amount of side error may exist, but a minor adjustment of the micrometer should cause the true star to appear below the reflected image. Should, however, the reflected image move to one side rather than move in a vertical motion, side error may be considered to exist.

The second way is by observing the horizon. Set the index arm at zero and hold the sextant just off the horizontal position. Look through the telescope at the true and reflected horizons. If they are misaligned, as indicated in Figure 3.6, then side error must be considered to exist.

To correct for side error, adjust the centre screw furthest from the plane of the instrument at the back of the horizon mirror, to bring either the star and its image into coincidence or the true and reflected horizons into line.

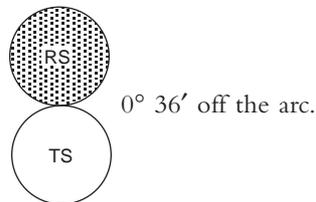
The third error, *index error*, is caused by the index mirror and the

horizon mirror not being out of parallel to each other when the index arm is set at zero. To check whether index error is present by observing a star, look through the telescope when the sextant is set at zero, and if the reflected image of the star is above or below the true image, then index error must be considered to exist. Should the true and reflected images be coincident, then no error will exist. To check by observing the horizon, set the index arm at zero, hold the sextant in the vertical position, and observe the line of the true and reflected horizons; if they are seen as one continuous line, then no error exists, but if the line between the true and reflected horizons is broken, an adjustment needs to be made to remove the error. This adjustment is made by turning the screw nearest to the plane of the instrument. Index error may also be checked by observing the sun. Fit the shaded eye piece to the telescope. Clamp the index arm at about $32'$ off the arc and observe the true and reflected images to the position of limb upon limb. Repeat the observation with index arm set at about $32'$ on the arc, and note the two readings of both observations. The numerical value of the index error is the difference between the two readings divided by two, and would be called 'on the arc' if the 'on the arc' reading were the greater of the two, and 'off the arc' if the 'off the arc' reading were the greater.

Let us consider an example:

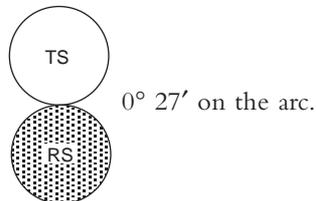
Adjust the micrometer to bring the true sun into contact with the reflected sun

Note the reading, for example



Repeat the observation, but with images the other way about.

Note the reading, for example



Take the difference of the two readings and divide by 2.

Index error is $\frac{36 - 27}{2} = 4.5'$ off the arc

This error must be subtracted from the future sextant readings.

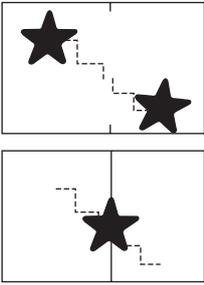


Figure 3.7 Dealing with combination of side and index error.

The accuracy of the observations may be checked by adding the numerical values of both readings together and dividing the number by four. The resulting value should equal the semi-diameter of the sun for the period at which the observation was taken.

Sometimes an instrument suffers from side error and index error combined. Should this undesirable condition be apparent, the mariner can resolve the problem by removing each error a little at a time, as shown in Figure 3.7. The correction is made by turning the second and then the third adjustment screws alternately, by a small amount each time, until coincidence of image is achieved.

Collimation error

This is an error caused by the axis of the telescope not being parallel to the plane of the instrument. To check whether the error is present, insert the inverting telescope, setting the eyepiece so that one pair of the cross wires are parallel to the plane of the sextant.

To check by observation of two stars (selected about 90° apart), move the index arm to bring the two stars into exact contact with each other resting on the wire nearest to the plane of the sextant. Now tilt the sextant upwards so as to bring them on to the wire which is furthest from the plane of the instrument. Should the images diverge or converge from the top intersections of the wires, it must be assumed that an error of collimation exists, and that the axis of the telescope is not parallel to the plane of the instrument.

This error can be corrected by adjustment of the two screws in the collar or telescope mounting. The screws are moved together, one being tightened, the other slackened, to align the stars on the top intersection which will bring the telescope back to parallel with the sextant frame. (Not all sextants, however, have adjustable collar screws.)

Non-adjustable errors

1. *Centering error.* This error could be caused by wearing of the pivot on which the index arm moves, perhaps because the index arm is not pivoted at the exact point of the centre of curvature of the arc.
2. *Prismatic error.* This error is caused by the two faces of the mirror not being parallel to each other.
3. *Shade error.* This is an error caused by the faces of shades not being parallel to each other. If it is known to exist, the telescope is used in conjunction with the dark eyepiece.
4. *Graduation error.* This error may be encountered on the arc itself or on the vernier or micrometer scales. If the micrometer drum is known to be correct, then the first and last graduations on the drum should always be aligned with graduation marks on the arc.

The manufacturer tables all the non-adjustable errors and issues the sextant with a certificate usually secured inside the lid of the case. The combination of the above four errors is known as 'Instrument Error'.

MARINE CHRONOMETER

The chronometer represents a fine example of precision engineering. The instrument is manufactured and tested under stringent quality-control methods to comply with marine authorities' regulations. The mechanical movement of the timepiece is manufactured as near to perfection as is humanly possible.

It is used for the purpose of navigation and is generally the only instrument aboard which records GMT (Greenwich Mean Time), all other clocks tending to indicate local mean time or zone time. It is normal practice for two chronometers to be carried by modern vessels, as a safeguard against mechanical failure or accident.

The chronometer is stowed if possible in a place free of vibration and maintained at a regular and even temperature. It must be accessible to the navigation officer but not so exposed as to allow irresponsible handling. By experience it has been found that the chartroom or wheelhouse area are ideal positions for this most important of ship's instruments.

The timepiece itself is slung in a gimbal arrangement, which can be locked in position, should the instrument have to be transported, the whole being encased in a strong wooden box fitted with a lock and binding strap. Most vessels are fitted with a glass-covered well which holds the ship's chronometers. These wells are often padded to reduce vibration effects, while the glass acts as a dust cover and permits observation of the clock.

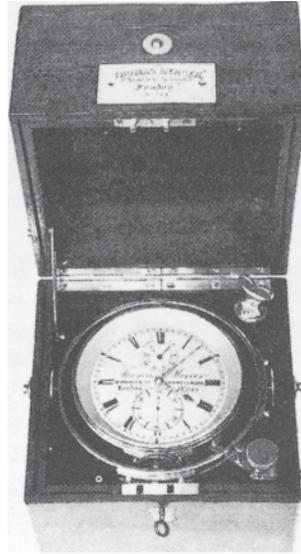
Usually a brass bowl is made to encase the mechanism. The bowl is maintained in the horizontal position by the gimbal arrangement set on stainless steel pivot bearings. A sliding, spring-loaded dust cover set in the base of the bowl allows access for winding.

Regularity is achieved via a torque-equalising chain to a fusee drum. The main spring is non-magnetic (of platinum, gold or palladium alloy), and is fully tested before the instrument is released.

The chronometer is fitted into an inner guard box fitted with a hinged, glazed lid. The outer wooden protective box is normally removed once the instrument has been transported to the vessel and secured in place.

Two-day chronometers should be wound daily at the same time. The winding key, known as the 'Topsy key', is inserted into the base of the instrument after inverting the bowl in the gimbals and sliding the dust cover over the key orifice. Chronometers are manufactured so that they cannot be overwound, the majority being fully wound after $7\frac{1}{2}$ half turns of the key anticlockwise. At this stage the person winding will encounter a butt stop which prevents further winding. A small indicating dial, on the clock face also provides indication that the instrument is fully wound.

Should the chronometer have stopped through oversight or other reason, it may become necessary to reset the hands on the face before restarting the mechanism. If time permits, it is best to wait until the time indicated is arrived at twelve hours later, then just restart the instrument.



7b. Marine chronometer.

However, this is not always practical, and if the hands need to be reset, they can be by means of the following method:

1. Unscrew the glass face plate of the chronometer.
2. Fit the 'Topsy key' over the centre spindle, holding the hands.
3. Carefully turn the key to move the hands in the normal clockwise direction.

Under no circumstances must the hands be turned anti-clockwise, as this will place excessive strain on the mechanism and may cause serious damage.

Starting the chronometer should be done in conjunction with a radio time signal, once the mechanism has been fully wound. It will be necessary for any person restarting a chronometer after it has stopped to give the timepiece a gentle circular twist in the horizontal plane. This effectively activates the balance and sets the mechanism in motion.

After starting, the chronometer should be rated on a daily basis against reliable time signals. Any error, either fast or slow, should be recorded in the chronometer error book, small errors being taken account of in navigation calculations.

THE GYRO COMPASS

The Sperry, Anschutz and Brown are three well-known makes of gyro compass and one of them will be found in most deep sea ships. The compass provides a directional reference to true north and is unaffected by the earth's magnetism and that of the ship.

A brief description follows but readers requiring more information on the theory and construction of the compass should consult more specialist literature.

Description and Application (The Three Degrees of Freedom)

The free gyroscope consists of a fast spinning rotor, mounted to provide three degrees of freedom: freedom to spin; freedom to turn about a

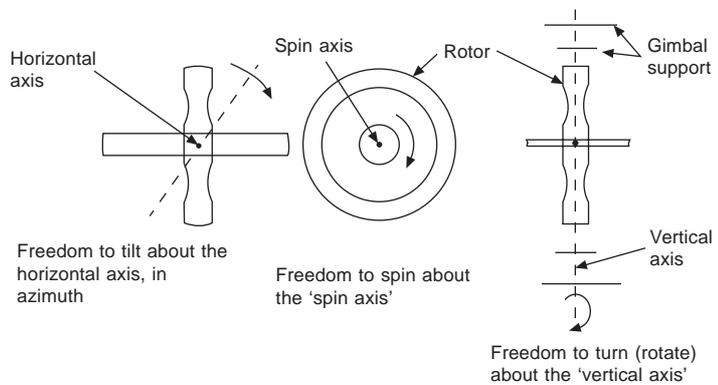


Figure 3.8 Degrees of freedom of rotor of free gyroscope.

vertical axis; and freedom to tilt about a horizontal axis. As the rotor is so constructed, to have a high mass, in relation to its dimensions, such a gyroscope displays two important properties:

- (a) gyroscopic inertia (rigidity in space) whereby it will point in space to a fixed direction and thus follow the apparent motion of a fixed star;
- (b) gyroscopic precession – the angular velocity acquired by the spin axis when torque is applied to the gyro in a plane perpendicular to the plane of the instrument.

These properties are made use of in the gyro compass, where a rotor spins at very high speed in nearly frictionless bearings, mounted with freedom to turn and tilt. The axle of the gyro is constrained by a system of weights producing a torque which causes the axle to precess (under the influence of gravity) in such a manner that it remains horizontal and in the meridian. The rate of precession of the gyro is equal to the rate at which the axle of the free gyroscope would appear to tilt and drift as the result of the earth's motion.

The Properties of the Free Gyroscope

It is important that the mariner understands the properties of the free gyroscope in order to understand the gyro compass.

Gyroscopic inertia

This term is often referred to as 'Rigidity in Space' which better describes this property. It is the ability of the gyroscope to remain with its spin axis pointing in the same fixed direction in space regardless of how the gimbal support system may turn. The term may be illustrated by considering the direction of a star in space. If the free gyroscope is set spinning with the spin axis pointing to that star, then it will be seen that, as the earth turns, the spin axis will follow the apparent motion of that star.

Precession

If a torque is applied to the spin axis of the free gyroscope then it will be observed that the axis will turn in a direction at right angles to that applied torque. This movement, by the rotor, due to the applied force, is known as precession.

Torque

Torque is defined as the moment of a couple or system of couples producing pure rotation. For a rotating body, torque is equal to the product of the moment of inertia and the angular acceleration.

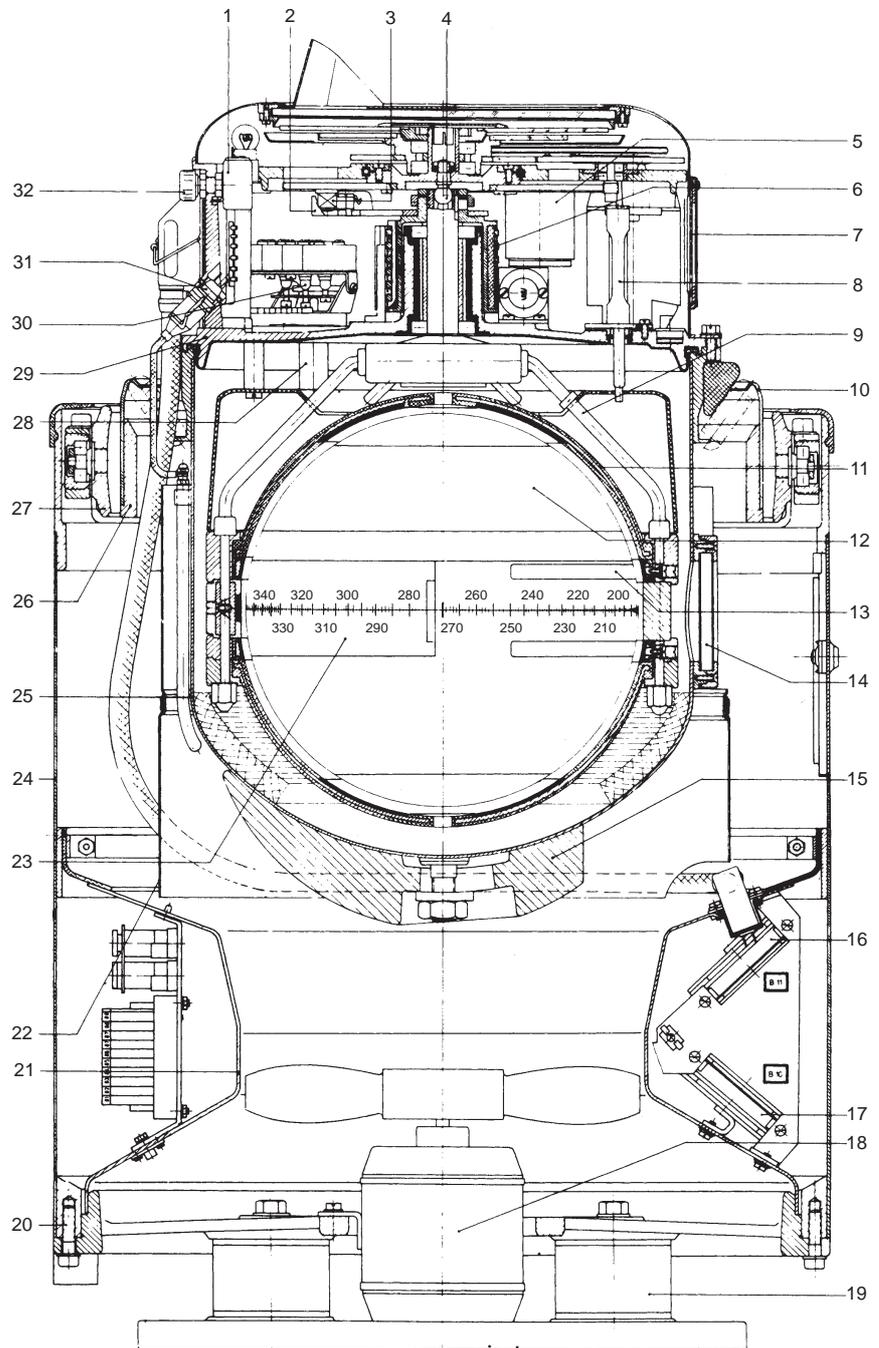


Figure 3.9 Anschutz Standard 4 gyro compass.

1. Dimming resistance for illumination.
2. Clip-on engaging arm.
3. Coupling block.
4. Centring ball of gear plate.
5. Follow-up motor.
6. Slip rings.
7. Inspection window for temperature readings.
8. Thermometer.
9. Spider leg.
10. Supporting ring with suspension springs.
11. Outer sphere.
12. Gyrosphere.
13. Narrow conducting band.
14. Window of liquid container.
15. Compensating weight.
16. Follow-up amplifier.
17. Symmetrical transformer.
18. Motor with fan.
19. Shock mounts.
20. Bolt connecting binnacle to pedestal.
21. Air duct.
22. Rubber skirt.
23. Broad conducting band.
24. Binnacle.
25. Liquid container.
26. Inner gimbal ring.
27. Outer gimbal ring.
28. Thermostat.
29. Top plate/supporting plate.
30. Micro-switch.
31. Cable connections.
32. Dimmer knob.

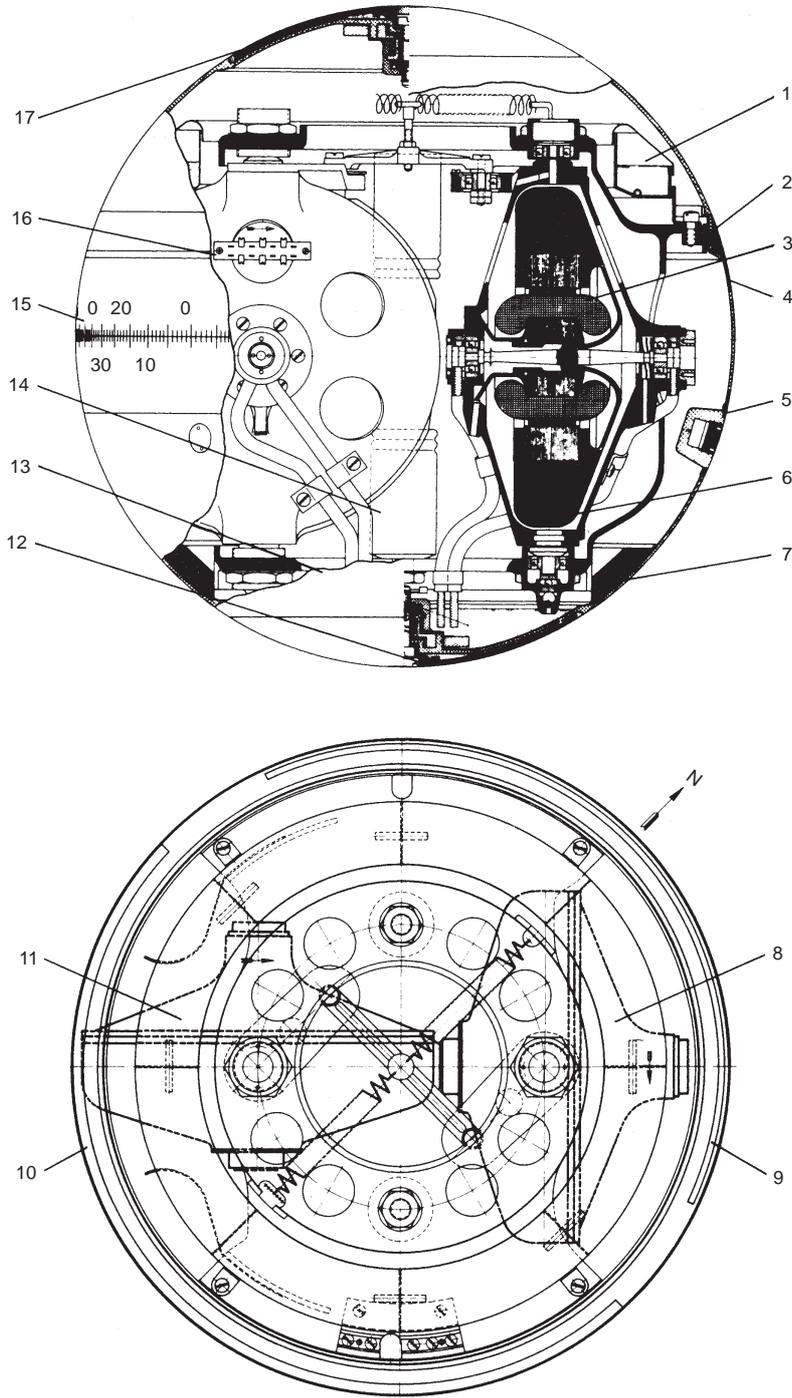


Figure 3.10 Anschutz gyrosphere for Standard 4 gyro compass.

1. Damping vessel.
2. Sealing ring of gyrosphere.
3. Gyro stator.
4. Narrow conducting band.
5. Narrow conducting band.
6. Gyro.
7. Repulsion coil.
8. Gyro casing 1.
9. Narrow conducting band.
10. Broad conducting band
11. Gyro casing 2.
12. Lower calotte (conducting dome).
13. Oil sump.
14. Capacitor.
15. Broad conducting band.
16. Terminal strip.
17. Upper calotte (conducting dome).

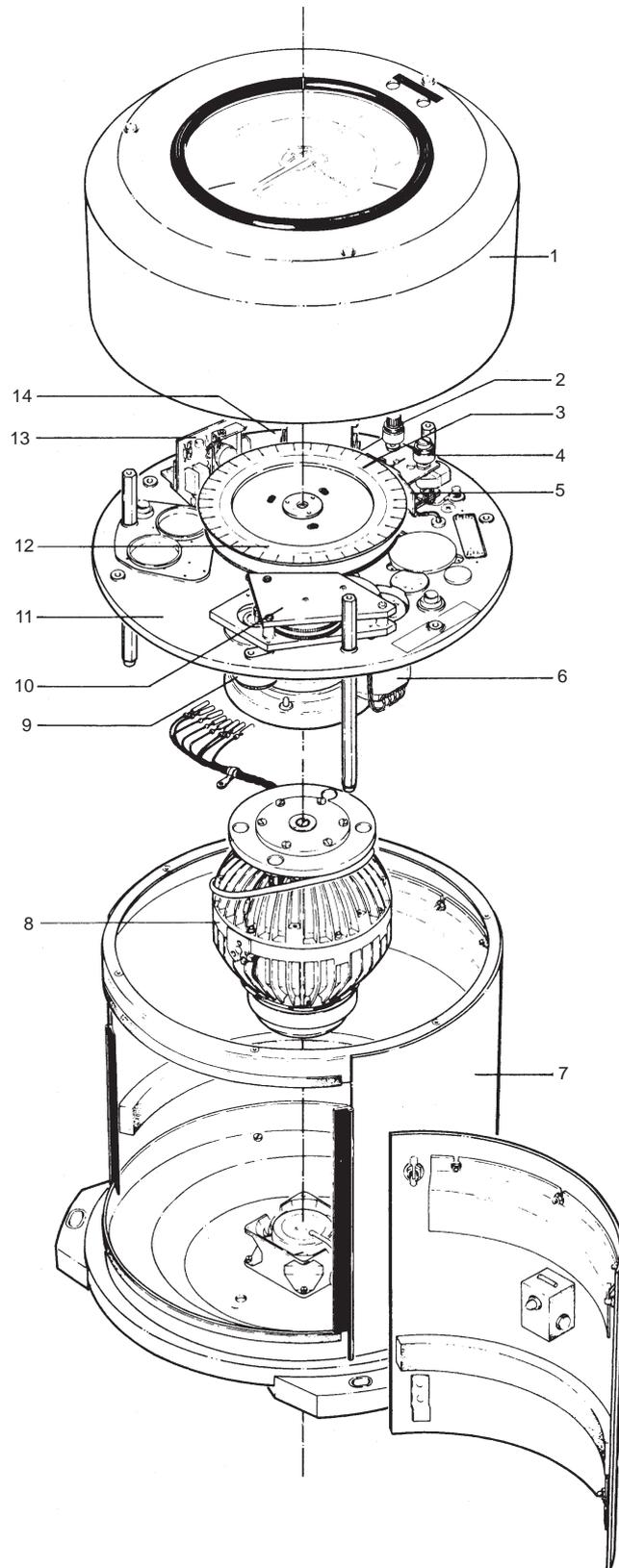
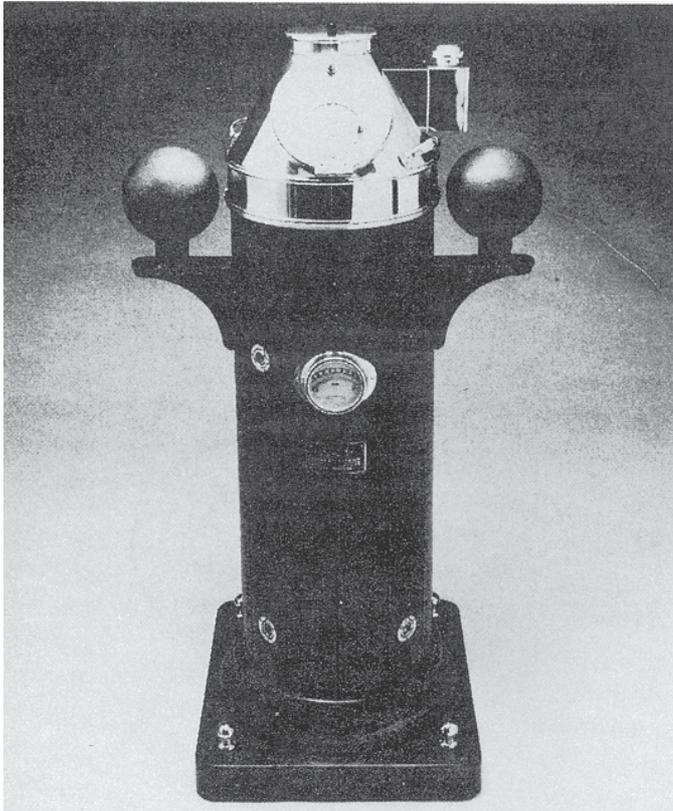


Figure 3.11 Anschutz Standard 12 gyro compass equipment.

1. Hood covering.
2. Dimmer switch for card illumination.
3. Lubber line.
4. On/off switch for follow up system.
5. Supporting plate for: 2, 13 and 14.
6. Transmitter.
7. Outer casing.
8. Outer sphere.
9. Servomotor.
10. Gear assembly.
11. Support plate carrying the outer sphere.
12. Compass card.
13. Amplifier.
14. Symmetrical transformer.



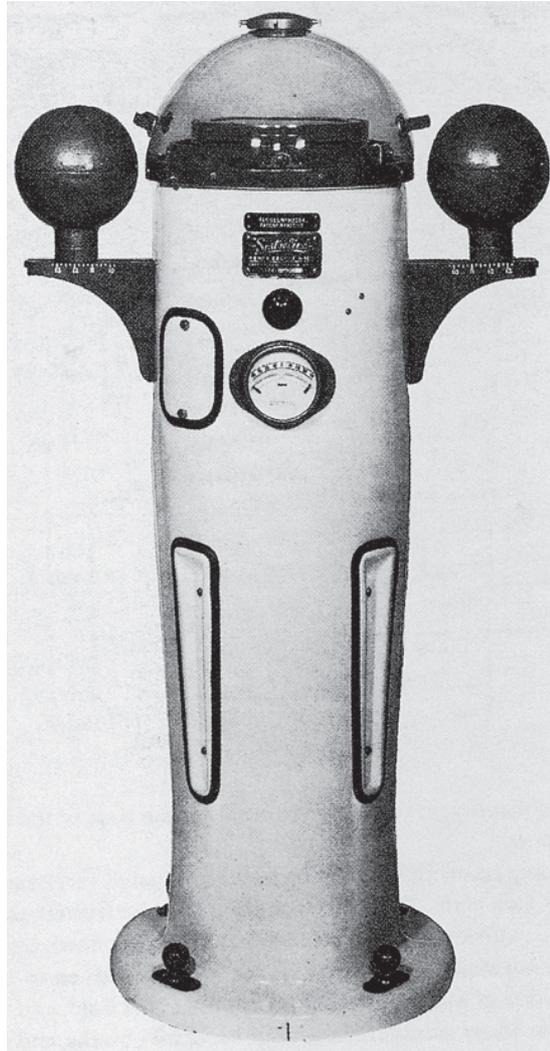
8. Binnacle in hardwood finish.

MAGNETIC COMPASS

This is without doubt the most important of all instruments aboard even the most modern vessel, and it is probably the most reliable. Its origins go back as long ago as 2300 BC, but the Chinese development of the compass card dates to the fourteenth century, and the sophisticated instrument we know today became established with the advent of steel ships in the nineteenth century.

The compass bowl is supported in a binnacle usually constructed of wood, but, increasingly, many binnacles are being made in fibreglass (Plates 8 and 9). The natural resilience of fibreglass absorbs vibration from machinery and requires little maintenance.

The main function of the binnacle is to provide support and protection for the compass bowl. However, the structure also provides the ideal support for the standard correction elements, namely the quadrantal correctors, the flinders bar, and the fore and aft and athwartships permanent magnets. Heeling error magnets are placed in a 'bucket' arrangement on the centre-line of the binnacle directly under the central position of the compass bowl (see Figure 3.12). The effect of heeling error magnets can be increased or decreased by respective adjustment of the chain raising or lowering the bucket.



9. Modern binnacle manufactured in glass-reinforced plastic.

LIQUID MAGNETIC COMPASS

This compass is illustrated in Figure 3.14.

Compass Bowl

Manufactured in high quality non-magnetic brass, this has a clear glass face and a frosted glass base to diffuse the underside lighting. The older designs were fitted with chambers to allow for the expansion and contraction of the fluid, but the modern compass is fitted with a corrugated diaphragm (elastic membrane) at the base of the bowl for the same purpose.

Most compass manufacturers include a graduated verge ring round the clear glass face plate. Both the face plate and the frosted glass base are secured via rubber gaskets to prevent leaks from the bowl. Special paints, used both internally and externally, are 'stove baked' on to the compass

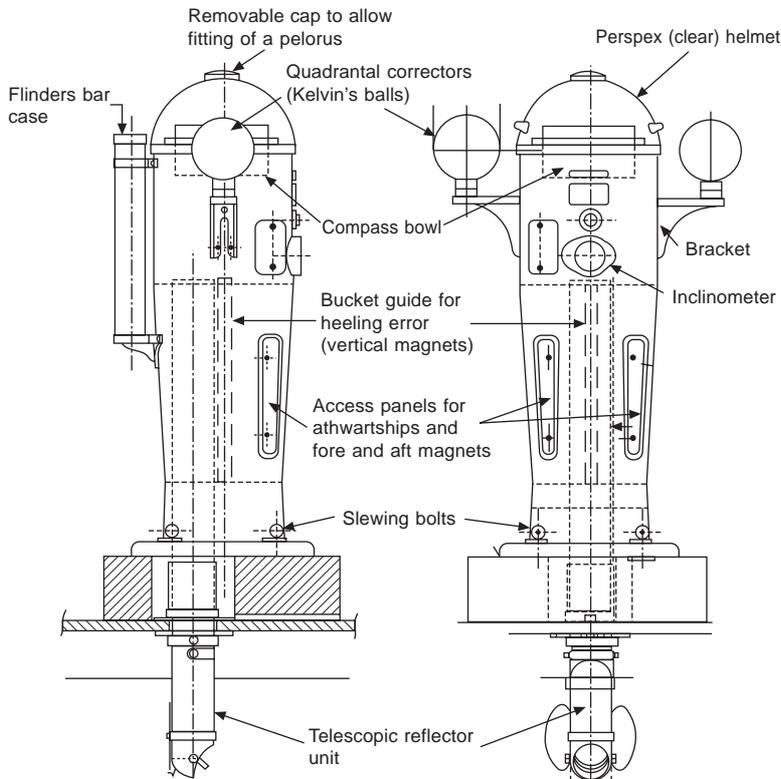


Figure 3.12 Magnetic compass. The chain adjustment for the heeling error bucket can be reached via the panel under the compass bowl into the light chamber.

body so that they will not cause discoloration of the fluid, and they last for many years. Many paints are magnetic, especially blacks, and their use on and around the binnacle should be limited. Brackets are fixed to the outside to connect to the gimbal system and a support is secured on the inside of the bowl to accommodate the pivot. The 'lubber line' is marked on the inside of the bowl, in alignment with the ship's fore and aft line.

Compass Card

Usually made of glass melamine or mica, it must be the correct size for the bowl to which it is fitted. Should another sized card be used, then fluid disturbances could make the compass unsteady. The diameter of cards varies, but a 10 in. (254 mm) compass bowl could expect a 7½ in. (191 mm) diameter card, unless a specially reduced card is provided.

In the course of manufacture the card is corrected for its magnetic moment, to limit its speed of movement, then checked for friction. Cards are normally screen-printed to indicate three-figure notation in degrees, and have the cardinal and half cardinal points identified. Intermediate and by-points are indicated but not individually lettered.

A single circular magnet is secured beneath the card to produce the directive force required of the compass. The magnet system may consist of two parallel circular magnets disposed on either side of the central line.



10. Liquid compass bowl in gimbal arrangement.

Pivot Point

This is made of polished iridium, a member of the platinum family, and care should be taken in manufacture that the iridium element is neither too hard, or it may shatter, nor too soft, or it may collapse. The bearing point is an industrial jewel, usually a sapphire, fitted into the base of a float set into the centre of the compass card.

The pivot point effectively lowers the centre of gravity of the card below the point of suspension. This arrangement is achieved by the inclusion of the dome-shaped float in the centre of the card. The magnetic system may be in the form shown, with a needle arrangement slung beneath the card, or a single circular magnet may be encased below the float. The casing is generally made of brass, to prevent rusting and loss of magnetic effect.

One of the main advantages of the liquid compass over the dry card compass is that it is not as sensitive. Consequently, it makes an excellent steering compass. Oscillations of the card are greatly reduced by the dense liquid within the bowl and any induced movement is practically eliminated.

The term 'dead beat' applied to the liquid compass means slow moving, with a steady card. Undesirable oscillations of the card are kept to a minimum by the liquid.

Liquid

The older style of liquid magnetic compass contained a mixture of two parts distilled water to one part ethyl alcohol, providing a fluid with low viscosity and a small coefficient of expansion. The idea behind the mix was that the alcohol would reduce the freezing point of the mixture in

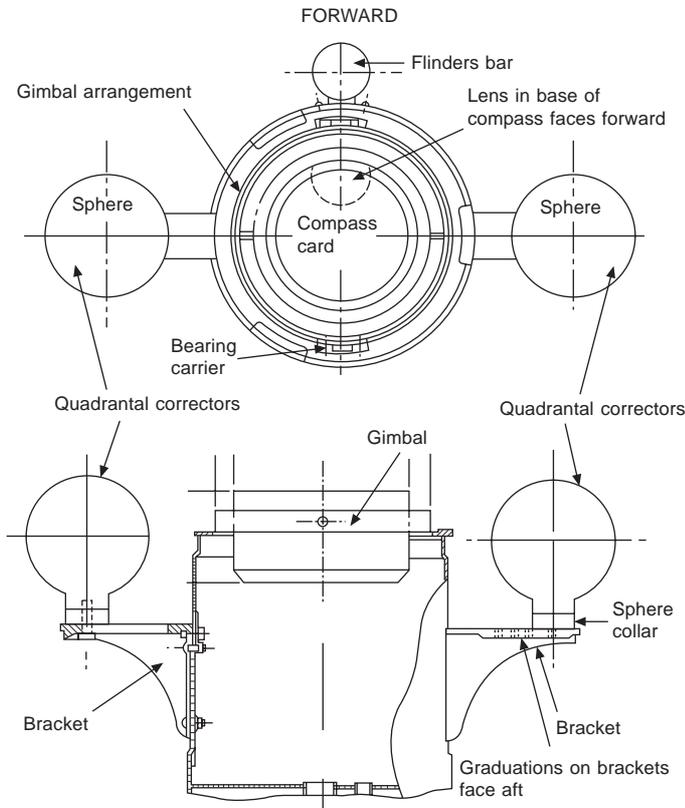


Figure 3.13 Siting of magnetic compass's correctors.

cold climates and the water would reduce evaporation in the warm tropical climates. The modern liquid compass employs an oily liquid derived from 'Bayol', which not only provides additional flotation for the card but also lubricates the pivot and reduces motion on the card.

In the manufacture of modern compasses the bowl, once assembled, is passed through a vacuum before being filled. The actual filling is carried out at an ambient temperature, and any final air bubbles are removed by manual joggling of the instrument (see Plate 10).

Gimballing

This means slinging the compass in such a manner that it remains horizontal at all times, even in a heavy sea. Keeping the compass card horizontal at all times may be achieved in two ways:

1. Raising the point of support of the compass card above the centre of gravity of the card.
2. Maintaining the compass bowl in the horizontal position by two axis/gimbal rings, one in the fore aft line and the other in the athwartships line.

It is usual to have the fore and aft axis secured to the outer gimbal ring

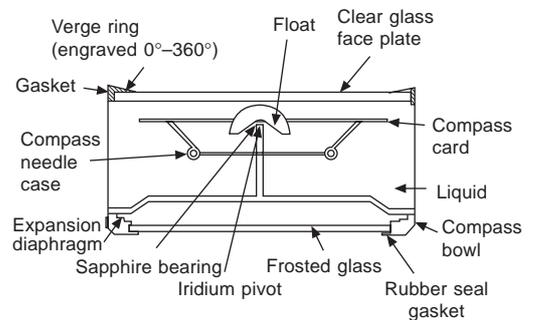


Figure 3.14 Liquid magnetic compass.

rather than the inner ring, as this reduces the possibility of the lubber's line mark travelling to port or starboard when the vessel is rolling heavily.

Order of Placing Correctors

Mariners are advised that to attempt to cover compass adjustment within the bounds of this text would be impractical. The reduction of deviation effecting the magnetic compass is complex and should be studied in depth. Use of correctors to compensate for permanent and induced magnetic effects must be carried out in a correct and orderly procedure.

A method of adjustment within the mercantile marine employs coefficients A, B, C, D, E and J for heeling error. These coefficients are types of deviation which vary in accordance with some ratio of the compass course.

For example: coefficient B is a deviation which varies as the sine of the compass course.

A thorough knowledge of the use of the coefficients together with a sound background of general magnetism must be considered essential to any mariner attempting the adjustment of the marine magnetic compass.

Marine students seeking further information should refer to: *The Ship's Compass* by G.A.A. Grant and J. Klinkert (Routledge and Kegan Paul).

1. *Flinders bar.*

This bar usually comes in lengths of 12 inches (30.48 cm), 6 inches (15.24 cm), 3 inches (7.62 cm), and $1\frac{1}{2}$ inches (3.8 cm), all of 3 inches (7.62 cm) diameter, with similar size wood blocks to raise the level of the bar and bring the pole of the bar, level with the magnets of the card. The pole is assumed to be one-twelfth the length from the end. This is explained by the fact that the pole of a bar magnet is never at the very end of the bar (Figure 3.15).

2. *Spheres.*

Employed in various sizes from 2 inches to 10 inches (5.08 to 25.4 cm) diameter, they may be of a solid or hollow construction. They are placed with their centres on a level with the magnets of the card but not closer than one and a quarter times the length of the longest needle in the card.

3. *Heeling error magnets.*

Hard iron magnets 9 inches in length (22.86 cm) by $\frac{3}{8}$ inch (0.93 cm) diameter, they compensate for heeling error due to field 'R' and vertical soft iron. They also induce magnetism into the flinders bar and spheres, which helps the heeling error correction.

4. *Horizontal magnets.*

These are 8 inches in length (19.32 cm) and either $\frac{3}{8}$ or $\frac{3}{16}$ inch (0.93 or 0.46 cms) in diameter. They compensate for the effects of the fore and aft and athwartships components of semi permanent magnetism.

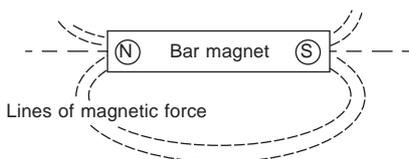
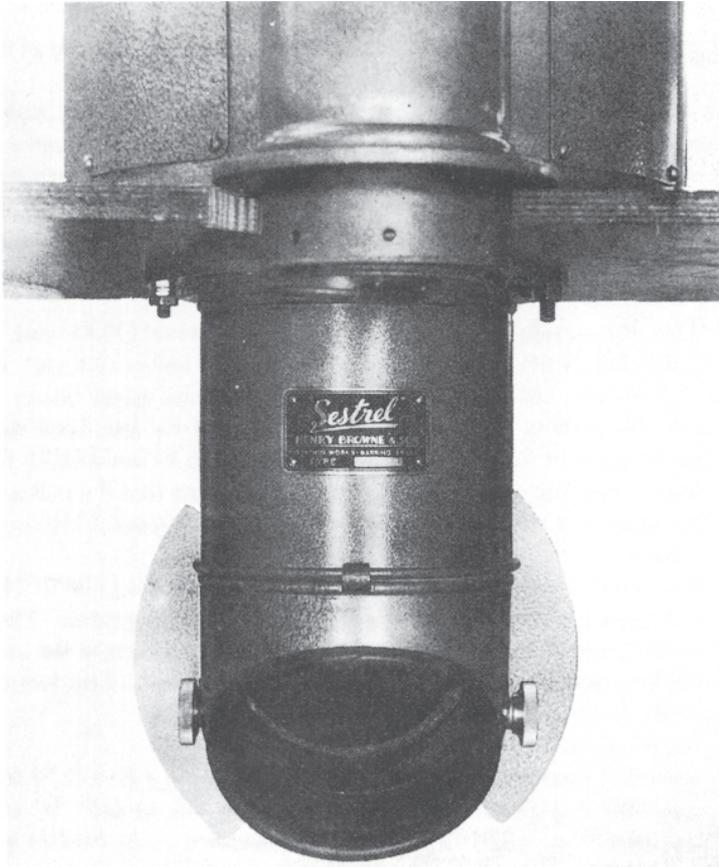


Figure 3.15 Lines of magnetic force.



11. Reflector unit.

Telescopic Reflector Unit

The majority of compass manufacturers will now supply ships' binnacles with or without telescopic reflector units (Plate 11), depending on the requirements of the ship owner. The reflector unit was an acceptable advance within the industry, since it obviated the need and the cost of providing a steering compass.

The idea of achieving a through-deck repeater from the standard compass on the 'Monkey island' is based on the development of the submarine periscope. The unit is fitted under the forepart of the compass in order to reflect the lubber's line and the foremost section of the compass card within the standard compass. The reflector unit is not centrally positioned, as the operation of the bucket containing the heeling error magnets would obstruct its use.

A typical reflector unit would be manufactured in PVC, with brass fittings. It usually incorporates moisture-free, sealed-in mirrors, which are adjustable at eye level inside the wheelhouse, together with a detachable anti-glare shield.

DRY HARD MAGNETIC COMPASS

This very sensitive instrument (Figure 3.16) has now been largely superseded by the more popular liquid magnetic compass. It is a very light card constructed of 'rice paper', the rice paper being segmented to allow an even flow of air above and below the card to obtain an even balance of pressure around the whole. The weight of the card is usually around 15 grammes, but it is given some rigidity by an aluminium ring beneath it, which also supports the magnetic needle arrangement.

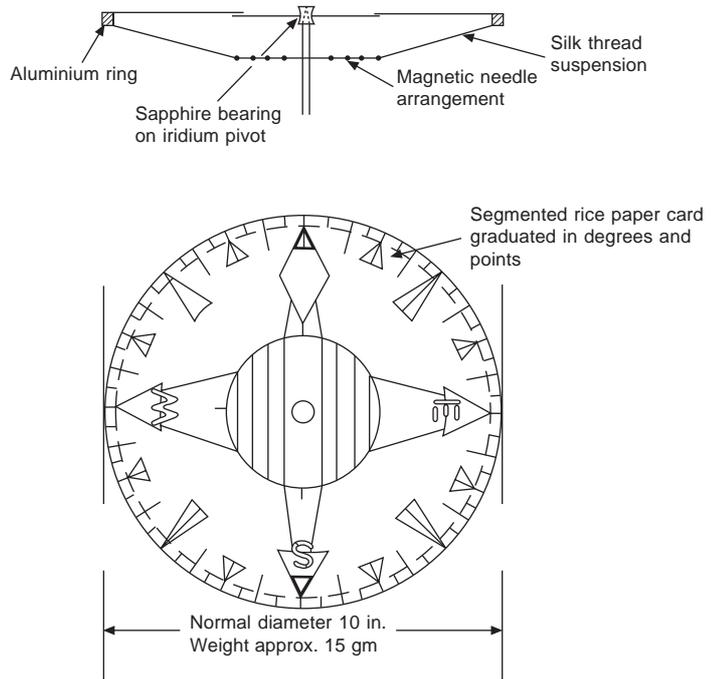
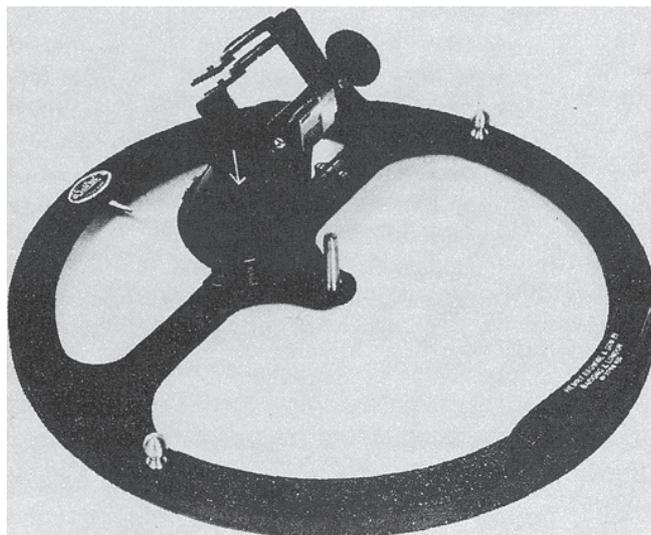


Figure 3.16 Dry card magnetic compass.



12. Azimuth mirror.

AZIMUTH MIRROR

This instrument (Figure 3.17 and Plate 12) fits on the compass bowl of either the standard magnetic or the gyroscopic repeaters, and allows the navigator to obtain accurate compass bearings of either terrestrial or celestial objects. The instrument has a stand, either triangular or round and usually manufactured in anodised aluminium and brass, designed to grip the verge of the compass bowl and provide a firm support for a reflecting prism. Most designs incorporate neutral tinted shades to allow observation of the sun, together with a shadow pin to provide a reverse bearing of the sun. Some more modern styles include two shadow pins for transit sighting.

For bearings to be taken accurately, the axis of the prism must at all times remain horizontal. To this end, the prism is held in its frame by two small screws, which may be adjusted if the prism loses its alignment. For operation of the azimuth mirror see Figure 3.18.

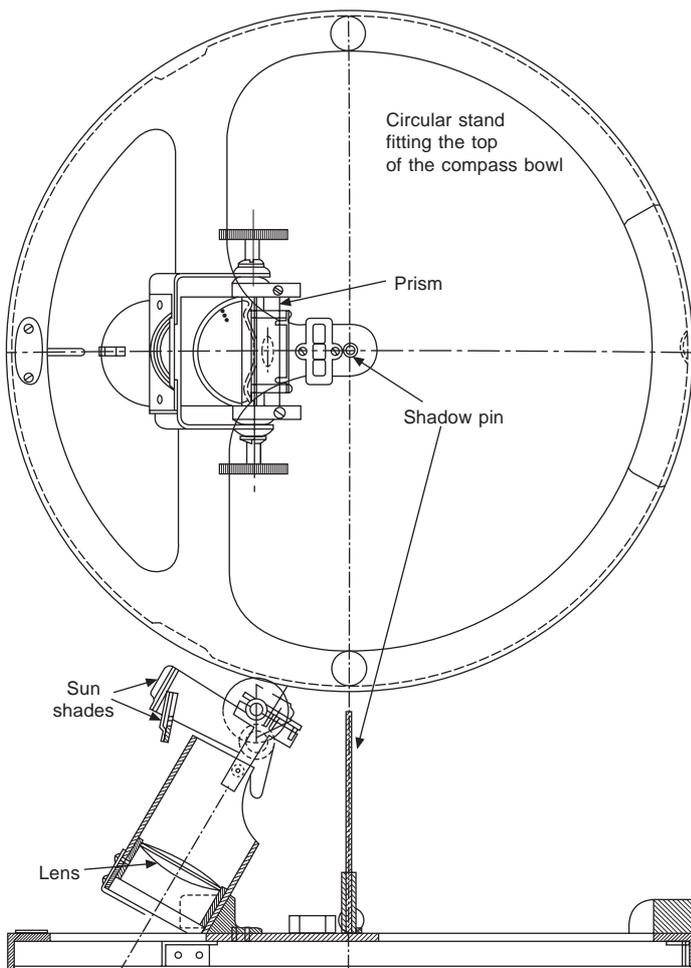


Figure 3.17 Azimuth mirror.

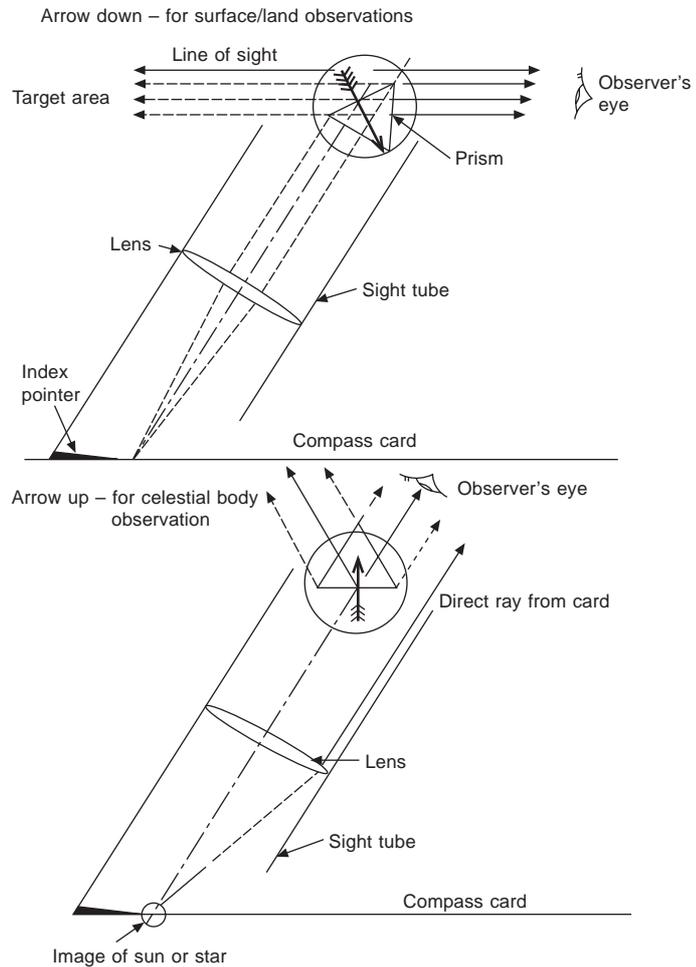


Figure 3.18 Operation of azimuth mirror.

Should the navigator at any time have cause to suspect the accuracy of the azimuth mirror, he may check by taking two bearings of the same object, one with the arrow in the up position and the second with the arrow in the down position. The results of both bearings – arrow up, arrow down – should be the same. Should a discrepancy exist between the results, then the prism should be adjusted.

PELORUS

The pelorus, which enables the navigator to obtain bearings of shore objects, is an alternative to the azimuth mirror. It is particularly useful when the line of sight of the azimuth mirror on the standard compass is obscured. Being a portable instrument, it can be transferred from bridge wing to bridge wing, so that the line of sight need never be impeded by such obstructions as the funnel. See Figure 3.19 and Plate 13.

In operation, the graduated bearing plate can be manually turned so as to be aligned with the ship's head, then clamped into position; and by

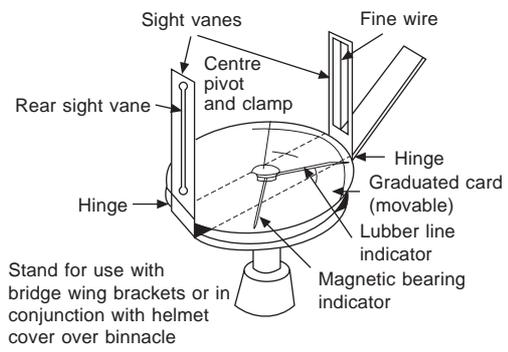
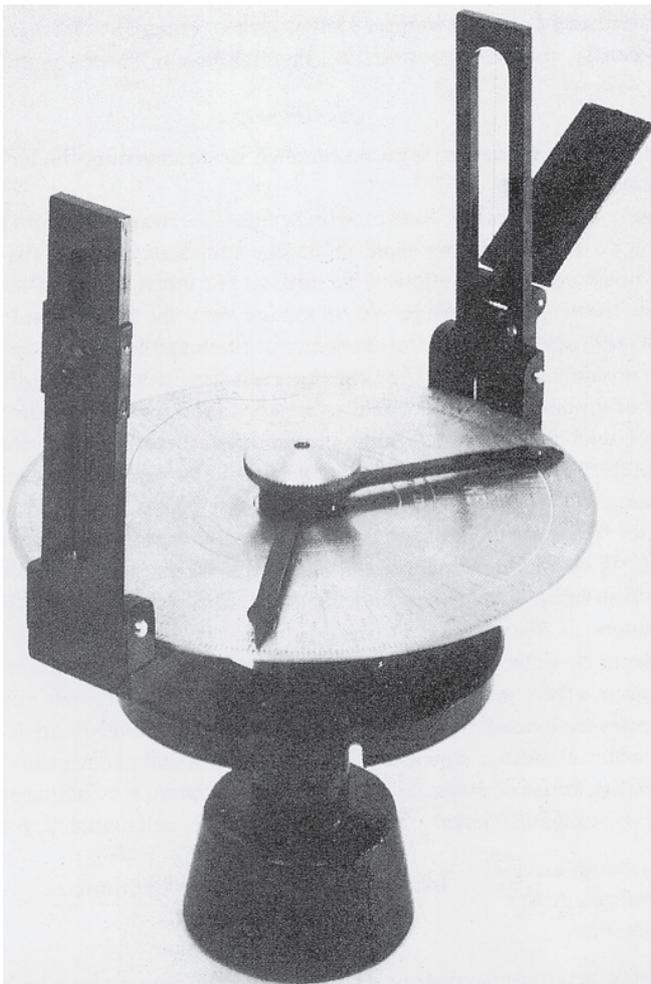


Figure 3.19 Pelorus.



13. Pelorus.

having an observer watching the ship's head and noting when the vessel is exactly 'on' course, the navigator can observe the true bearing by means of the sight vanes aligned with the shore object. Relative bearings may also be obtained by having the lubber line indicator set at 000° .

HYDROMETER

This instrument (Figure 3.20) is used by ships' officers to determine the relative density of fluids, including the dock water in which a vessel is lying while loading. It is necessary to obtain the amount that the load line mark may be submerged when in dock water of less than 1025 kg/m^3 , and then, by use of the dock water allowance formula, define the draught limits so that once the vessel is at sea, she is correctly loaded to her loadline marks.

Ships' hydrometers are usually made in polished steel or brass, but they may also be made of glass. A bulb weighted with lead shot or mercury acts to keep the graduated stem in the vertical position. The operational principle of the hydrometer is based on the laws of flotation of Archimedes. The mass of the stem, float chamber, and shot is a constant. If the hydrometer floats in a fluid, then the weight of fluid displaced will equal the volume of hydrometer times the density of fluid. The density can be determined by practical use of the instrument.

Operation

The following procedure is recommended for determining the density of the dock water.

Use a clean 2-gallon bucket with a light line attached and obtain a sample of the dock water from about the midships point of the vessel. The bucket should be allowed to sink to the mean draught level and remain there for a short period to ensure that the temperature of the bucket will agree with that of the water at the mean level. The sample of water should not be taken from the upper surface, as this will probably be polluted in some way and will also be at a different temperature to the water round the submerged hull – and temperature affects the density of fluids. By the same reasoning the bucket should be cast clear of overboard discharges.

After that, float the hydrometer in the bucket of water once the liquid is still. Give the instrument a slight twist to break surface tension and allow it to settle. Read off on the scale the level of the surface at which the instrument is floating.

The dock water allowance formula is now applied. When a vessel is loading in a dock which is not a salt-water dock, the ship may submerge her appropriate loadline by an amount equal to that value obtained by the dock water allowance formula. This statement is only correct for vessels proceeding into salt water of 1025 kg/m^3 , and should a vessel be

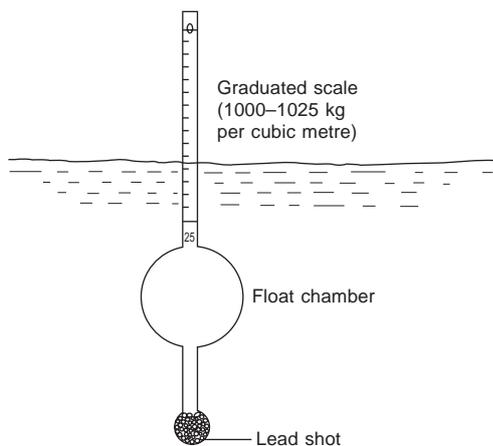


Figure 3.20 Hydrometer.

entering water of a different density, this would have to be calculated accordingly.

The amount a vessel may submerge her loadline mark = $\frac{1025 - \text{Density shown on hydrometer}}{25} \times \text{FWA}$

when FWA represents fresh water allowance (the amount by which a ship may submerge her seasonal loadline when loading in fresh water of density 1000 kg/m³).

HYGROMETER

This is an instrument for measuring relative humidity. Marine hygrometers are normally used in conjunction with a 'Stevenson's screen', which allows the air to circulate freely inside but protects the hygrometer from the direct force of the wind and the chill factor.

The hygrometer consists of two thermometers secured side by side. The mercury bulb of one is kept dry, and this is known as the 'dry bulb thermometer'. The other thermometer has a muslin wick covering the mercury bulb, and the end of the wick is dipped into a small distilled water reservoir. This is known as the 'wet bulb thermometer'. The whole is often referred to as the Mason's hygrometer or just the 'wet and dry bulb thermometer'.

The hygrometer is used in conjunction with calibrated tables to obtain not only the relative humidity but also the dewpoint. These values are indicated by the difference between the wet and dry bulb temperatures.

The process of evaporation requires heat, and this heat is drawn from the wet bulb thermometer. Evaporation of the distilled water in the reservoir and more directly from the wick takes place, leaving the wet bulb thermometer generally at a temperature below that of the dry bulb. Should the air be saturated at the time of observation, then the temperatures indicated by both wet and dry bulb thermometers will in fact be the same.

The readings are useful to ships' officers in predicting the condensation of moisture in the atmosphere. This fact is particularly relevant to vessels whose cargoes would be at risk from 'cargo sweat', owing to improper ventilation. It should also be noted that high levels of moisture in the air may indicate the approach of a tropical storm or depression.

PRECISION ANEROID BAROMETER

Precision aneroid barometers (Figure 3.21) have been widely used at sea since about 1963. Their compact, robust construction has proved ideal for the marine environment, especially when compared with the mercury barometers. They have proved easy to transport and are less liable to damage than mercury barometers, as well as having a simple method of reading from a digital readout.

Displacement of the aneroid capsule is measured by means of a micrometer spindle which is connected via gears to the digital readout

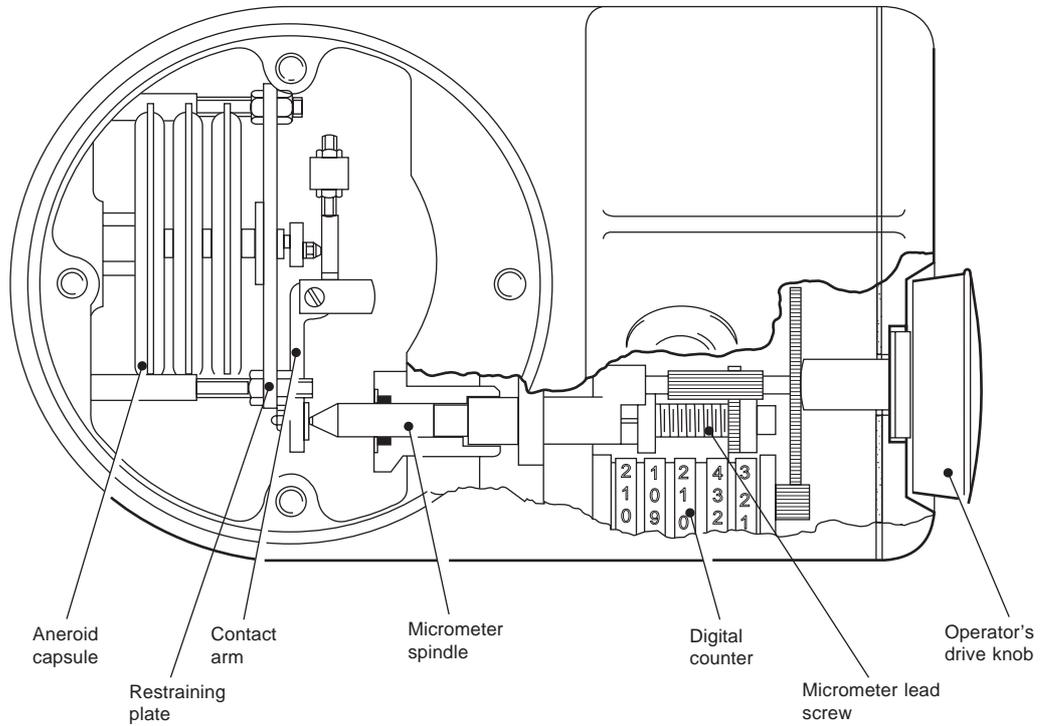


Figure 3.21 Precision aneroid barometer.

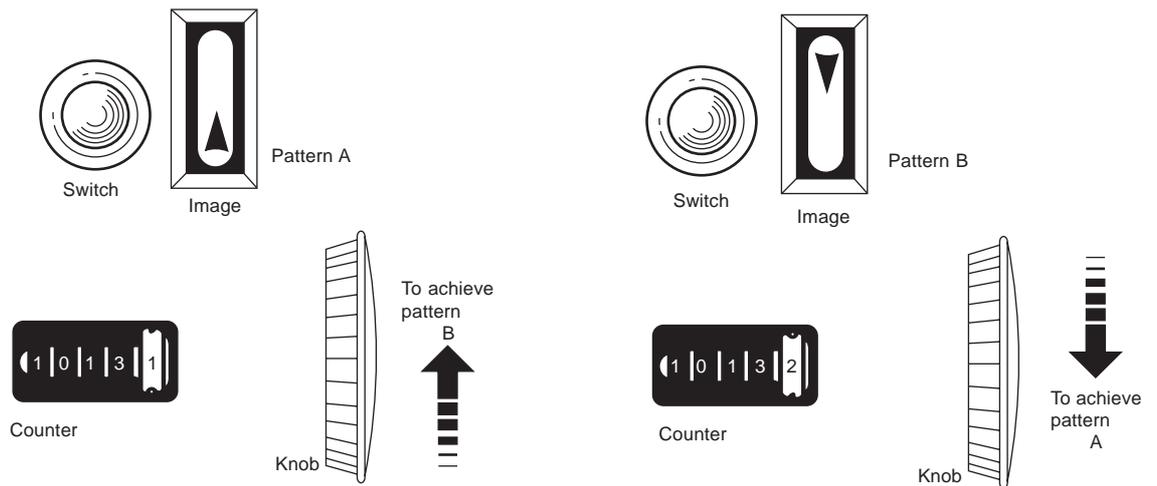
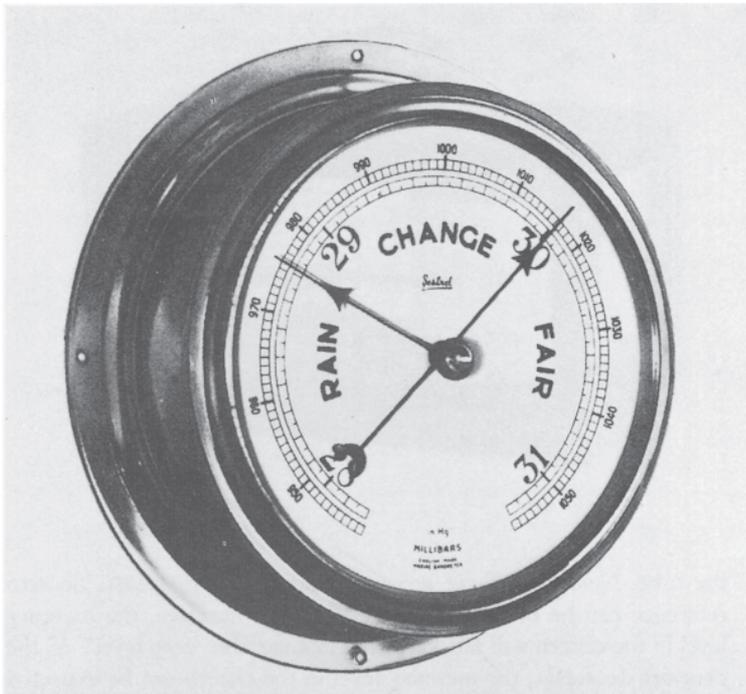


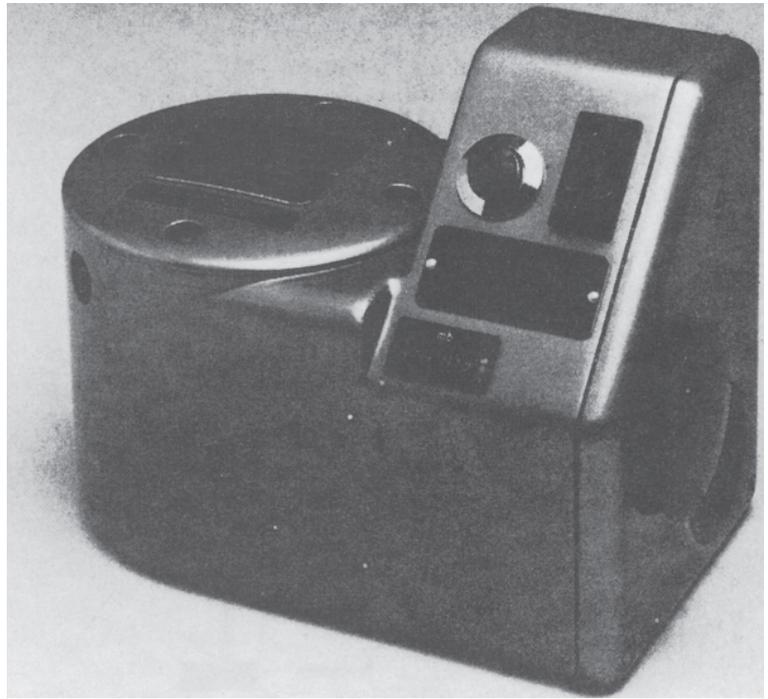
Figure 3.22 Operating procedures for precision aneroid barometer.

counter. A contact arm positioned between the spindle and the capsule acts as a simple lever with a ratio of 3:1 for adjustment purposes and as a safeguard against damage. Barometric pressure is indicated on the digital counter after adjustment of the operator's drive knob. This adjustment causes the micrometer spindle to break contact with the contact arm. Contact between the arm and the spindle is detected by an electronic circuit powered by dry batteries having a service life of three to nine months depending on use (see Figures 3.21 and 3.22).

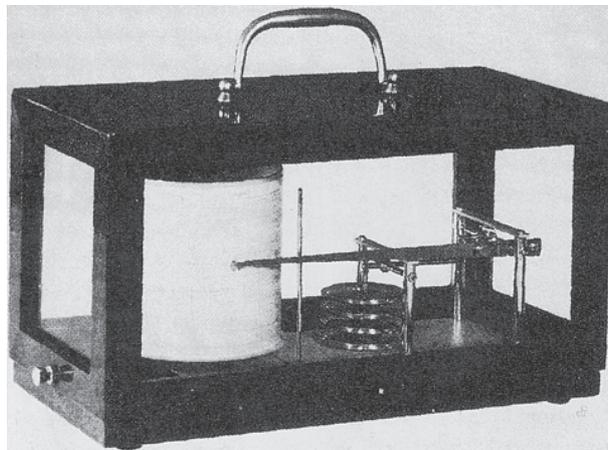
The conventional and the precision aneroid barometer are shown respectively in Plates 14 and 15, and the marine barograph in Plate 16.



14. Conventional aneroid barometer.



15. Precision aneroid barometer.



16. Marine barograph.

METEOROLOGY



METEOROLOGICAL TERMS

Anabatic

This term refers to the upward movement of air due to convection. An anabatic wind ascends a hillside or blows up a valley.

Anemometer

This is an instrument used to register and determine the velocity of the wind.

Aneroid Barometer

A dry mechanical instrument for measuring changes of pressure in the atmosphere.

Anti-cyclone

An area of high pressure, with clockwise circulation of air in the northern hemisphere, and anti-clockwise in the southern hemisphere, defines an anti-cyclone. Winds are generally light to moderate.

Aurora

This shimmering area of light is caused by an electrical discharge in the atmosphere over high northern and southern latitudes. The Northern Lights are called the Aurora Borealis, and the Southern Lights the Aurora Australis.

Backing

This means a change in the direction of the wind in an anti-clockwise sense, e.g. from north through west to south and then east. This is the opposite of veering, which occurs when the wind direction changes in a clockwise direction.

Bar

An international unit of atmospheric pressure, at sea level a bar is equal to the pressure of a column of mercury 29.53 in. high at a temperature of 32°F at latitude 45°.

Barograph

This instrument provides a permanent record, in graphical form, of the continuous changes in atmospheric pressure. It may be described as a continuous recording aneroid barometer.

Barometer

This is an instrument for measuring barometric pressure. Corrections are made to the readings for latitude, temperature, and height above sea level. The instrument will also carry an index error, which may be found on its certificate.

Barometric Tendency

The change in barometric pressure indicated during the three hours preceding observation is the barometric tendency. It shows the rise or fall of atmospheric pressure.

Cold Front

Cold air travelling over the earth's surface can sometimes lodge itself under warmer air. A sloping separation between the layers of warm and cold air is defined as a 'cold front'.

Condensation

This is the process of converting a vapour into liquid.

Conduction

Heat transfer through a body from places of higher temperature to those having a lower temperature is called conduction.

Convection

This is a process of heat transfer being carried out in a fluid, when the heat is carried by the motion of the hot fluid itself.

Corona

Faint blue rings about the moon, brought about by diffraction of and interference with light by water droplets in the atmosphere.

Cyclone

Often referred to as a depression or just as simply a low, this is an area of low pressure about which the air moves in an anti-clockwise direction in the northern hemisphere and vice-versa in the southern hemisphere. It is also the term given to violent revolving tropical storms.

Dew

An accumulation of water droplets on objects cooler than the temperature of the air.

Dewpoint

This is the temperature to which air can be cooled without condensation taking place.

Diffraction

Light is diffracted when light waves pass through narrow apertures or between bodies forming narrow apertures. See 'Corona'.

Doldrums

This area of calm, variable winds lies between the NE and SE Trades. Occasional squalls and torrential rain may be encountered within the area.

Etesian

A northerly wind encountered among the Greek islands, the Etesian is of katabatic origin. See 'Katabatic wind'.

Evaporation

In this process water or ice are converted into an aqueous vapour.

Fog

It is defined as visible water vapour at the earth's surface. Mist may be similarly defined, except that mist tends not to impede navigation to the same degree as fog. A state of fog exists when visibility is less than 1000 yd (914.4 m).

Gale

A strong wind in excess of 40 knots and represented by forces 8 and 9 on the Beaufort Wind Scale constitutes a gale. Cone-shaped signals exhibited by coastal stations give warning of the approach and direction of a gale.

Gulf Stream

This warm water current flows from the Gulf of Mexico up the east coast of the United States and then moves in an easterly direction, as the North Atlantic Drift Current, towards the European continent.

Hail

A hard ice pellet, which generally falls from cumulo-nimbus cloud, hail is usually associated with thunderstorms. Hailstones vary in size. They are built up by concentric layers of ice forming on top of each other. One theory is that the nucleus is a particle of dust which attracts moisture, and the moisture subsequently freezes.

Halo

A circle of light caused by refraction, which forms about the sun or moon.

Haze

A reduction of visibility caused by dust or smoke in the atmosphere, limiting the range to about 1.25 miles (2 km), haze is not to be confused with mist, which is brought about by condensed water particles.

Horse Latitudes

This term is given to the area of calm and light, variable winds between the 30th and 40th parallels. In general, they lie between the trade winds and the prevailing westerly winds.

Humidity

The amount of moisture in the air is the humidity.

Hurricane

This is an exceptionally strong wind, measuring force 12 on the Beaufort Wind Scale. A tropical cyclone, not uncommon in the North Atlantic and the Caribbean Sea, is a hurricane. Its counterpart in the Indian Ocean and the Far East is known as a typhoon, from the Chinese word *Tai-fung*.

Hydrometer

An instrument for obtaining the relative density of a fluid, it is used extensively to obtain the dock water allowance and test boiler water.

Hygrometer

An instrument for obtaining the relative humidity of the air, it comprises two thermometers, one a wet bulb and the other a dry bulb. The thermometers are usually contained in a box known as a Stevenson's screen which allows the passage of air currents.

Ice

Ice is frozen water. For types of ice, see 'Ice terminology', p. 78.

Isobars

These are lines drawn on a weather map to connect areas of the same barometric pressure.

Isotherms

These are lines drawn on a weather map to connect areas of the same temperature, and they may also be used to express the sea or air temperatures.

Katabatic Wind

This is the name given to a wind produced by a downward current, which is especially prevalent in high coastal areas. The wind 'runs' down the hillside, its velocity increasing with gravity, and it can expect to meet the sea often with great violence.

Land and Sea Breezes

Evening temperatures over land and sea tend to be reasonably equal, but at night the temperature over the land falls and the pressure increases, the state of equilibrium is upset, and a current of air moves towards the sea. The opposite phenomenon takes place in morning.

Lightning

A discharge of electricity between two clouds, or between a cloud and the earth.

Mirage

Abnormal refraction and reflection of light rays may cause a false horizon in the lower layers of the atmosphere because of the differing densities of the layers. When mirage is seen over water, distant ships may appear, sometimes upside down.

Monsoon

This seasonal wind blows over much of SE Asia, sometimes from the land and sometimes from the sea. In fact, it may be compared to the definition for land and sea breezes above, except that the occurrence is seasonal rather than daily, and over a much larger area.

Phosphorescence

This luminous effect on the surface of the water, showing bluish points of light, has never been explained satisfactorily.

Polar Front

This is the line of demarcation between a cold polar air mass and warmer air from more temperate latitudes.

Precipitation

The conversion of water vapour into visible rain, snow, sleet, hail, dew etc. is called precipitation.

Radiation

This is the process of heat being transferred by wave energy.

Rain

This comprises water droplets, formed by the condensation of water vapour. The maximum size of each droplet will not exceed 5.5 mm, and its maximum velocity, depending on size, when falling will not exceed 17.9 mph (29 kmph).

Rainbow

An arc formed by refracted and reflected light from water droplets in the atmosphere, it can only be seen when the observer is looking into a rain cloud or shower of rain with the sun at his back.

Recurvature of Storm

Often referred to as the vertex of the path of the storm, the recurvature represents that point which is as far west as the centre of the tropical storm will reach. Also known as the 'cod'.

Refraction

This is the bending of a ray of light when passing from one medium to another of different density.

Ridge

The term may be applied to a 'ridge of high pressure', indicating a bulge or extension of a high pressure area between two lows.

Sleet

A mixture of rain and snow or partially melted snow becomes sleet.

Snow

Light ice crystals fall as snow.

Squall

This is a sudden change in wind velocity, often increasing considerably over a short period of time, with little warning. It can consequently cause serious damage, especially to small craft.

Stratosphere

This is the region of the atmosphere above the troposphere in which the lapse rate is about zero and in which the phenomena comprising 'weather' do not occur. The stratosphere begins at a height of some 11 miles at the equator.

Temperature

A condition which determines heat transfer from a hot to a colder body. Temperature may be expressed in degrees Fahrenheit (°F), Celsius (°C), Kelvin (°K) or Absolute (°A).

Thunder

This is a violent report caused by the expansion of air as it becomes heated along the path of a lightning flash.

Rumbling thunder is experienced at a distance from the lightning, and may be accentuated by echoes. As sound travels through the air at 1100 ft per second, and light travels at the rate of 186,000 miles per second, there is always a delay after a lightning flash before the observer hears the sound of thunder.

Tornado

A violent whirlwind about an area of low pressure, the tornado is most common in the United States, where they have been known to create considerable damage. The diameter of the whirlwind area is small, usually 50–200 m, but wind speeds may be in excess of 200 knots about the centre. Actual wind speed in the centre is zero, but updraft may lift objects into the air.

Trade Winds

Permanent winds which blow towards the equator, trade winds usually measure between 3 and 5 on the Beaufort Scale. They are generally referred to as NE Trades when they blow over the North Atlantic and North Pacific from below latitude 30°N towards the equator, and SE Trades when they blow from latitude 30°S towards the equator over areas of the South Atlantic and the South Pacific.

Trough

This is an extension of low pressure from a low-pressure centre. It is the opposite to a ridge, which is the outward extension from a high-pressure centre.

Twilight

A period of reduced light which occurs after the sun dips below the horizon, it is caused by the rays of sunlight being refracted in the atmosphere towards the earth.

Veering

See 'Backing'.

Vertex

The turning point in the path of a tropical revolving storm, the vertex is the position in which the path of the storm moves to an easterly from a westerly direction in the northern hemisphere.

Visibility

This is the maximum range at which an object is discernible. The state of visibility may be assessed by using the length of the ship when in dense or thick fog conditions. It may similarly be assessed when in poor visibility by noting the time taken for an approaching vessel to become visible, making due allowance for the respective speeds of the two ships. When assessing good visibility, it is not good practice to use the range of the visible horizon, owing to the possibility of distortion by refraction, especially in misty or hazy conditions. Excellent visibility may be ascertained when heavenly bodies are seen to be coming over or dropping under the horizon when rising and setting.

Warm Front

This is a line of demarcation between advancing warm air and a mass of cold air, over which the warm air is rising.

Waterspout

Caused by an extension, usually from a nimbus cloud, it will extend to the surface of the sea, causing agitation of the water, which effectively turns to a spout. The result is a column of water vapour, which may last for up to half an hour. Shipping is advised to give it a wide berth.

Wave

A disturbance of the surface of the sea, a wave is caused by the wind. Waves will vary in size and height. When a wave breaks on the coast line, it is referred to as a 'breaker'.

Wedge

A ridge of relatively high pressure, situated between two low pressure areas, it is often roughly wedge-shaped.



Figure 4.1 UK coastal forecast areas.

Wind

The movement of air parallel or nearly parallel to the surface of the earth, the wind is named after the direction from which it comes.

FORECAST AREAS

Figures 4.1 and 4.2 map the UK coastal forecast areas and the weather reporting stations respectively, and Figure 4.3 the North Atlantic areas.

WEATHER SCALES

Tables 4.1 to 4.3 cover the Beaufort Wind Scale and weather notation, fog and visibility scale, and wave scale.



Figure 4.2 Present weather – UK Coastal. Ships requiring actual weather conditions around the coastline of the British Isles can obtain such reports from any of the Met Stations shown. However, the stations may only be manned during office hours or in the event of a casualty risk being present. Sella Ness has limited opening times.

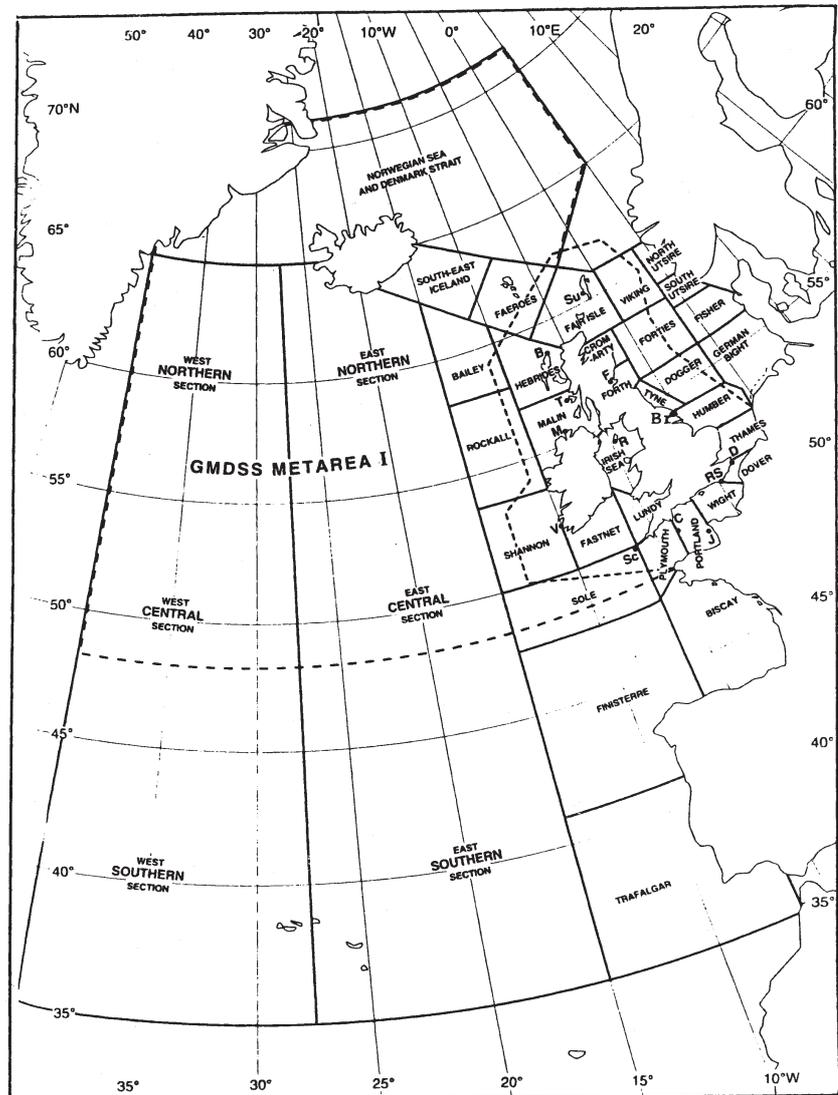


Figure 4.3 Sea areas and associated marine communication areas effective under the GMDSS operation.

CONSTRUCTION AND INTERPRETATION OF SYNOPTIC CHART

Meteorological offices around the world in many participating countries collect and collate weather reports and related information for the benefit of safe navigation. Weather reporting vessels, together with aircraft and satellite pictures, provide reasonable forecasts for all major shipping areas.

The reports from all sources allow a comprehensive weather chart to be produced. Symbols used are shown in Figure 4.4a.

The following information is typical of the normal weather report:

1. Position of reporting station, latitude and longitude.
2. Speed of reporting station (knots). Course of vessel.
3. Barometric pressure, correct for sea level. Indication of movement.
4. Weather description in Beaufort Scale notation (letter).

TABLE 4.1 Beaufort Wind Scale

<i>Beaufort Scale number</i>	<i>Wind description</i>	<i>Wave description</i>	<i>Height of sea in ft</i>	<i>Knots in nautical mph</i>
0	Calm	Flat calm, mirror smooth	—	0–1
1	Light airs	Small wavelets, without crests	0.25	1–3
2	Light breeze	Small wavelets, crests glassy but not breaking	0.5	4–6
3	Light breeze	Large wavelets, crests beginning to break	2.0	7–10
4	Moderate breeze	Small waves, becoming longer, crests breaking frequently	3.5	11–16
5	Fresh breeze	Moderate waves, longer with crests breaking	6.0	17–21
6	Strong breeze	Large waves, forming, crests breaking more frequently	9.5	22–27
7	Strong wind	Large waves, streaky foam	13.5	28–33
8	Gale	High waves, increasing in length, continuous streaking of crests	18.0	34–40
9	Strong gale	High waves, crests rolling over, dense streaking	23.0	41–47
10	Storm	Very high waves, overhanging crests, surface white with foam	29.0	48–55
11	Violent storm	Exceptionally high waves, surface completely covered with foam	37.0	56–65
12	Hurricane	Air filled with spray, visibility impaired	—	over 65

5. Air temperature.
6. Wind force and direction.
7. Sea state. Description of any swell.
8. Ice accretion.
9. Cloud cover and description.
10. Date and time of observation.

For ease of transmission, reports are coded by use of the *Code and De-Code Booklet*, issued by the Meteorological Office and obtainable from Her Majesty's Stationery Office.

Once all the coded reports from stations in the area have been received, decoding takes place, and the lowest barometric pressure is marked on the weather chart at its point of observation. Due allowance is made for the station's course and speed from the time of observation to the moment of reception. The term LOW is then recorded on the chart, and isobars, joining places of equal barometric pressure, are sketched in lightly.

Arrows are then added to indicate wind direction. The mariner should bear in mind that the arrows will generally cross the isobars in the direction of the LOW. Speed of the wind in knots is indicated, together with barometric pressure in numerical form. Wind speed used to be indicated by the number of feathers attached to the drawn arrows, to represent wind speed under the Beaufort Scale, but this practice is no longer as popular as in the past.

TABLE 4.2 Beaufort weather notation

<i>Symbol</i>	<i>Meaning</i>
b	Blue sky with clear or hazy atmosphere, with less than one quarter of the sky area clouded
c	Cloudy with detached opening cloud, where more than three-quarters of the sky area is clouded
bc	Sky area clouded over between one-quarter and three-quarters of the total area
d	Drizzle or fine rain
e	Wet air with no rain falling
f	Fog
fe	Wet fog
g	Gloomy
h	Hail
kq	Line squall
l	Lightning
m	Mist
o	Overcast sky
p	Passing showers
q	Squalls
r	Rain
rs	Sleet
s	Snow
t	Thunder
tl	Thunderstorm
u	Ugly threatening sky
v	Unusual visibility
w	Dew
z	Dust haze

TABLE 4.3 Wave scale

<i>State of sea</i>	<i>Height in metres</i>
Calm – glassy	0
Calm – rippled	0–0.1
Smooth wavelets	0.1–0.5
Slight	0.5–1.25
Moderate	1.25–2.5
Rough	2.5–4.0
Very rough	4.0–6.0
High	6.0–9.0
Very high	9.0–14.0
Phenomenal	over 14.0

<i>Length of swell</i>	<i>Length in metres</i>
Short	0–100
Average	100–200
Long	over 200

<i>Height of swell</i>	<i>Height in metres</i>
Low	0–2.0
Moderate	2.0–4.0
Heavy	over 4.0

Type of front	Symbol as used on printed charts
Quasi-stationary	
Quasi-stationary, above the surface	
Warm	
Warm, above the surface	
Cold	
Cold above the surface	
Occlusion	
Instability line	
Intertropical	
Convergence line	
Warm airstream (not in common use)	
Cold airstream (not in common use)	

Figure 4.4(a) Symbols for fronts, as plotted on a synoptic weather chart.

The letters of the Beaufort notation are added to describe the apparent weather condition around the observer's area, together with any relevant information regarding storms, ice, fog etc. (see Figure 4.5).

CONTINGENCY PLANS FOR HEAVY WEATHER

1. Verify vessel's position. Investigate safe port options.
2. Obtain up-to-date weather forecasts and expected weather predictions, for surrounding areas.
3. Warn all departments of impending heavy weather.
4. Rig lifelines fore and aft.
5. Check following: anchors and securing, lifeboats and lashings, watertight doors, and general cargo stowage and securing, especially deck cargo lashings.
6. Close up ventilation, removing cowls where appropriate.

Figure 4.4(b) Maritime Rescue Co-ordination Centres (MRCCs) are continuously manned around the United Kingdom, together with fifteen Maritime Rescue Sub-Centres (MRSCs). All these stations may respond to local weather conditions but such information given would be only applicable to present weather in the vicinity of the station and would include forecasts for other areas.



7. Check stability – no slack tanks.
8. Note preparations in log books.
9. Contact shore station, passing position and obtain constant plotting of storm's track.
10. Secure derricks/cranes and hatch covers.
11. Clear surplus gear from decks.
12. Close down deadlights.
13. Slacken off signal halyards and other relevant cordage.
14. Drain swimming pool.
15. Reduce manpower on deck by operating heavy weather work routine.
16. Take down awnings.
17. Secure bridge for excessive pitching and rolling motion.
18. Warn engine room in plenty of time to reduce revolutions.
19. Check distress rockets and LSA gear.
20. Organise meal reliefs before bad weather arrives.

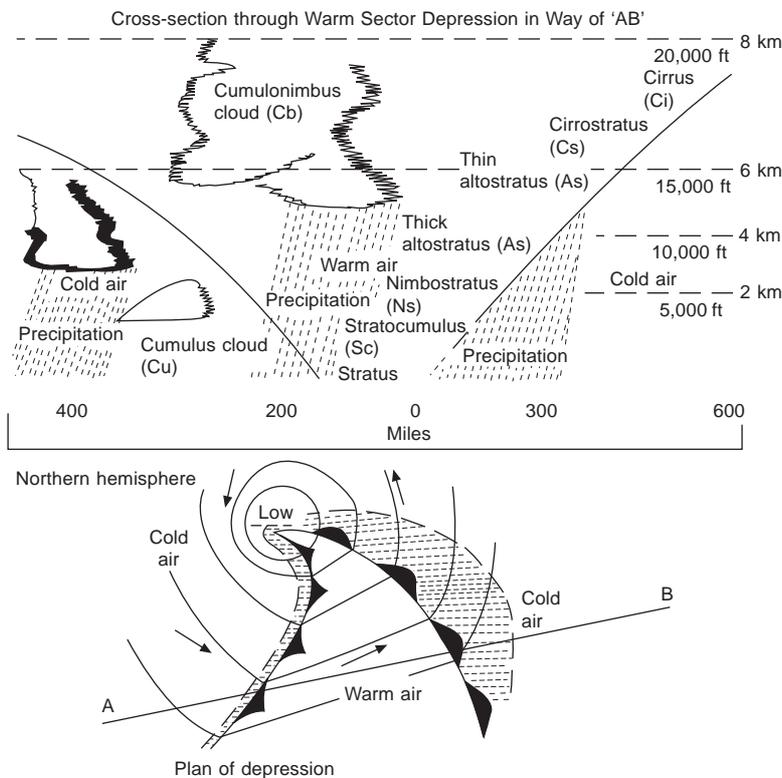


Figure 4.5 Interpretation of a synoptic weather chart.

EFFECTS OF HEAVY WEATHER ON VESSEL AT SEA

To describe the behaviour of any vessel in a heavy sea the mariner should first be aware that every vessel, depending on her build, GM, state of loading etc. will perform differently.

Stiff and Tender

A large GM will render a vessel stiff, i.e. give her a short period of roll, and subsequent damage may be sustained by rapid rolling. A small GM will render the vessel tender, i.e. she will have a long slow roll motion. These two conditions, usually brought about by incorrect loading or ballasting, should be avoided, so that unnecessary stress in the structure of the vessel when in a seaway is avoided also.

Periods of Roll and Encounter

Period of roll may be defined as that time taken by a ship to roll from port to starboard, or vice-versa, and back again. The 'period of roll' will be to a great extent controlled by the GM of the vessel and by the disposition of weights away from the fore and aft line.

Period of encounter may be defined as that time between the passage of two successive wave crests under the ship.

If we consider the behaviour of a vessel with a short period of roll compared to the period of encounter, then the vessel will tend to lie

Figure 4.6 Vessel with short period of roll compared to period of encounter.

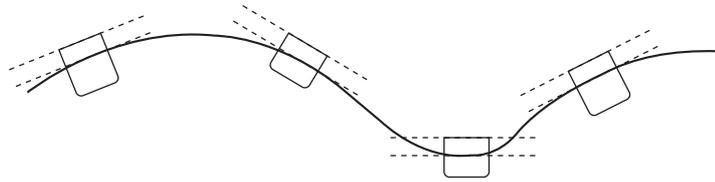


Figure 4.7 Vessel with long period of roll compared to period of encounter.



with her decks parallel to the water surface or wave slope. The ship will probably suffer violent and heavy rolling and may suffer damage because of this. However, she will not generally ship a lot of water in this condition (see Figure 4.6).

If we consider the behaviour of a vessel with a long period of roll compared to the period of encounter, then the vessel may be expected to roll somewhat slowly and independently of the waves. The vessel will probably experience only moderate angles of roll, and the waves may be expected to break near the ship's side (see Figure 4.7).

Synchronism

This is most dangerous and highly undesirable condition for a vessel to experience and occurs when the period of roll is equal, or nearly equal, to the half period of the waves. Successive waves tend to increase the angle of roll of the vessel, producing the possible danger of capsize. It is imperative that the watch officer should recognise the condition immediately, especially in a small vessel, or when the range of stability is small. An immediate alteration of the vessel's course will effectively change the period of encounter and eliminate the condition, which is probably at its most dangerous when a beam sea is experienced and the ship reaches a greater maximum inclination at each crest and hollow. Cargo is liable to shift and the vessel will most certainly be damaged if the condition is left uncorrected for any length of time.

Synchronised pitching – when the period of encounter is similar to the vessel's period of pitch – may also occur. This situation can be alleviated by an alteration of speed, preferably a reduction, as an increase may cause the vessel to 'pound'. A vessel which has suffered engine failure is most vulnerable to synchronised rolling and efforts to bring the vessel's head into the wind should be made while she still has headway (headreach).

GENERAL BEHAVIOUR OF VESSELS IN HEAVY WEATHER

The options available to a vessel running into heavy weather can be restricted to five main categories:

1. Head to sea, or with wind and sea fine on the bow, running at reduced speed.

2. Stern to sea, at reduced speed, running before the wind.
3. Heaving to, preferably in the lee of a land mass, to allow the weather to pass.
4. Anchoring, depending on depth of water.
5. Altering course in plenty of time to take evasive action away from adverse weather conditions.

It has been pointed out that the successful handling of any ship will be dependent on the circumstances at the time and the characteristics of the ship in question. Draught, state of loading, superstructure, turning circles etc. will all influence decisions taken for the safety of the vessel.

Head to Sea (or with wind and sea fine on the bow)

This is probably the most favoured position for a deep-draughted vessel. Leeward drift is minimised, but the vessel is liable to sustain considerable punishment, owing to continual pounding. Should a vessel be designed with increased scantlings, as for ice navigation, the concern might not be as great as in, say, a vessel with no additional strengthening built in.

The object is to head the vessel into the weather, with the idea of letting the weather pass over her. To this end, the speed of the vessel is considerably reduced, which will affect the period of encounter of the on-coming wave formations and subsequently reduce any pounding that the vessel is experiencing. It may become necessary to stop the ship's engines on the approach of extremely heavy seas, effectively reducing all headway. Courses and speed should be altered to remove the possibility of hogging or sagging, and to prevent synchronism.

This situation can be a most uncomfortable one, with the vessel pitching violently at times. Violent pitching may result in 'racing propellers', which in turn puts excessive stress on engines. Absolute control of rudder and power is essential. As a rule of thumb, power should be reduced to the minimum necessary to maintain steerage way and avoid undue stress on machinery. Two steering motors should be operational, if fitted, and any zone of critical revolutions should be avoided.

Stern to Sea

Bad weather may often overtake the vessel at sea and she will effectively find herself running before the wind. It is usual to take up a course with the wind on the quarter rather than dead astern, this action tending to make things more comfortable on board for all concerned. If the wind and sea are acting directly from astern, then a vessel will run the risk of a surf effect, as waves build up under the stern. In addition, vessels with a low freeboard will run the risk of 'pooping'.

Pooping occurs when a vessel falls into the trough of a wave and does not rise with the wave, or if the vessel falls as the wave is rising and allows the wave to break over her stern or poop deck area. Hence the name 'pooping', which may cause considerable damage in the stern area.

The mariner should consider the speed of the vessel in all conditions of heavy weather, and what the effects of an increase or decrease would

be on the periods of encounter and the effective wave impact; but generally the vessel's speed should be eased down until she is handling comfortably.

Generally speaking, the vessel with a following sea will not move as violently as a vessel head to sea. Trial and error will determine an optimum speed and minimise adverse motions of the ship. Speed adjustment, together with the long period of encounter, will probably reduce wave impact without any great delay to a ship's schedule.

The main concern for a vessel with the wind and sea abaft the beam arises if and when the vessel is required to turn. A distinct danger of attempting to turn across the wave front is that the vessel may 'broach to'.

A following sea reduces the flow of water past the rudder, so that steering may become difficult, and prevent the vessel's head coming up to wind. With reduced rudder effect, the vessel may be caught in an undesirable beam sea and may 'broach to', being unable to come into the wind and sea.

Heaving to

The prudent Master, after due consideration of all the circumstances, might be well advised to take what may at first appear to be the easy option. This may prove to be just that, with the wind blowing itself out in a very short time. However, this is not always the case, and a Master may encounter problems associated with crew fatigue or the spoiling of cargo through heaving to for a lengthy period of time.

Obviously, circumstances must dictate the actions in every case, but if it is possible to take advantage of a lee caused by some land mass, then this can often be the answer to the immediate problem. This practice is employed frequently in the coastal trades, especially with vessels carrying cargoes liable to shift, e.g. roll on—roll off, grain etc.

If general heavy weather is encountered at sea, well away from coastlines, the action taken by the Master will depend on the type and form of the vessel. A reduction of speed will probably be one of the early actions to reduce the motions of the vessel and eliminate the possibility of cargo shift. Such reductions in the vessel's speed should be limited, to permit correct steerage under the adverse weather conditions. Power should not be reduced to such an extent that stalling of the main machinery occurs, nor should revolutions be allowed to oscillate about any critical zone of revolutions for that type of main engine.

Another alternative under the heading of heaving to, is when it is decided to stop main engines altogether. This action could result in considerable drifting of the ship and sufficient sea room should be available before the operation is begun. Heavy rolling can be expected, with the ever present risk of synchronism and the real problem of shifting cargoes.

For this alternative to be successful, a vessel needs to have good watertight integrity, together with an adequate GM. The use of storm oil may become a necessity, once the vessel has taken up her own position. Oil should only be used to maintain the safety of the vessel

and/or life. It should be distributed on the windward side of the vessel, in an amount sufficient to reduce the immediate hazards.

Spreading vegetable or animal oil on heavy seas will prevent wave crests from breaking over the vessel but will have little or no effect on the swell waves about the hull area. The use of mineral oils should be avoided, especially if people are in the water. Lubricating oils are a possible alternative but heavy fuel oils should be avoided at all costs.

The oil may be spread via the hawse pipes forward or by the scuppers and/or toilet overboard discharges. Distribution via the hawse pipes is particularly useful to any vessel engaged in a towing operation, for not only will the tow gain the benefit of the oil but also the vessel towing.

Smaller craft, such as fishing boats and supply vessels, may need to use oil in order to prevent the sea waves breaking over the vessel and 'icing-up' taking place in the colder latitudes. Oil may require warming or thinning down in very cold climates, and a suitable spirit may assist its flow and distribution.

Should a decision be taken to use oil, then only enough to achieve the objective should be employed. It should be remembered that large waves which break and surf will effectively reduce and destroy the oil film.

Use of Anchors

One of the greatest fears of any Master is that of being blown down on to a lee shore. Many shipwrecks caused in this way could have been avoided by anchoring in deep water, say 25–50 fathoms.

If the vessel is in shallow water, consideration should be given to the use of two anchors, and the expected strain on cable(s). Many vessels founder on a lee shore because they become disabled, loss of power resulting in subsequent grounding, or insufficient power preventing them from 'beating out' to seaward. The process of anchoring with or without engine power will reduce the rate of the vessel's drift to leeward. The possibility of the anchors holding is a real one. Even if grounding is not prevented, then refloating may very well be assisted by heaving on cables.

Use of Sea Anchors

The idea of rigging an efficient sea anchor to keep the vessel head to wind is feasible for a small vessel, if a sea anchor can be constructed easily, but it is doubtful if any Master of a super tanker or even just a large vessel would consider the idea. To be effective, the sea anchor would have to be of an unmanageable size, even if the ship were equipped with the necessary lifting gear and materials to make one, which is highly unlikely.

For small craft such as coasters and large yachts, a sea anchor will reduce the lee drift, and keep the boat head to wind, but for the majority of vessels it is a non-starter and they should consider other possibilities. Any floating object that will offer reasonable resistance to the drift of the ship will behave as a sea anchor, and mooring lines paid out over the

bow will sometimes be useful. Large ships, especially those having high freeboard, would probably need outside help, such as a tug, in dangerous situations.

The situation may be more appreciated if the mariner considered a VLCC or ULCC ship, with small crew and little in the way of suitable equipments for jury rigging.

TROPICAL REVOLVING STORM

The tropical revolving storm (TRS) normally forms in low latitudes, usually between 7° and 15° north or south of the equator. It cannot form in very low latitudes, or for that matter near land masses. These storms are often called hurricanes, typhoons or cyclones, but to seafarers they are all tropical revolving storms (see Figure 4.8).

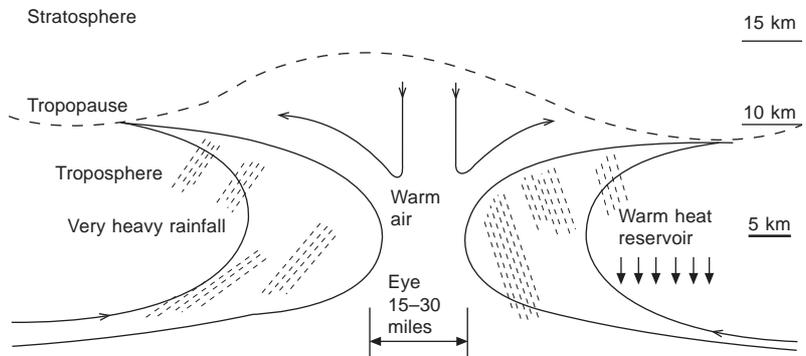
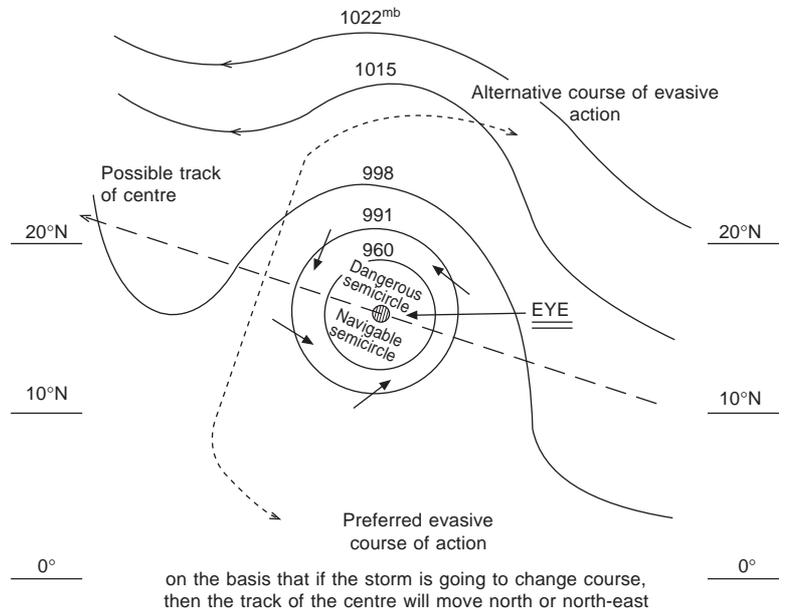


Figure 4.8 Tropical storms.

A storm will develop over open seas where the temperature and humidity are high, and some form of trigger action is available to set off the violent convection. The storm is made up of intense asymmetrical line squalls, which spiral inwards towards a central point, known as the 'eye'. The eye of the storm will vary in size but is generally 15–30 miles in diameter. This area is known to be a comparatively calm area, of warm air from the sea surface, right up to the stratosphere.

Wind speeds are in excess of 64 knots and may reach as high as 200 knots, with gale force winds extending from the eye up to a range of 300 miles. The barometric pressure will be exceptionally low and may fall below 900 mbs. A very high humidity level will be experienced, together with very heavy rainfall in the area.

A tropical storm may take up to 5 days to form and reach a mature stage, but once this stage is reached, it may take several weeks before it dissipates. However, the normal period for a tropical storm's life is between one and two weeks. Should the storm move inland, the associated violent weather can be expected to diminish within 48 hours of crossing the coastline.

The general movement of a tropical storm will probably be in a westerly direction, either in the northern or southern hemispheres. Speed of movement will vary but the average is about 10 knots. Once clear of the tropical latitudes, it is not uncommon for the track to move north or north-east, or south or south-east, in the northern and southern hemispheres, respectively.

Evasive Action

It is the duty of the Master of any vessel to report the position and movement of any tropical storm if it has not already come to the attention of the authorities. The eye of the storm should be plotted, together with its rate of movement and probable path. Other dangers to the vessel's navigation should also be plotted in relation to the storm's path.

The Master of any vessel should ascertain at the earliest possible moment his own vessel's position and which 'semi-circle' he is in or entering. By full consideration of all the facts, a course of evasive action should be taken as quickly as possible to avoid crossing the path of the storm. Prudent use of the vessel's full speed should be quickly made, as it may become necessary to reduce speed later to avoid pounding and damage to the vessel.

Obviously any Master faced with a tropical storm must make his decisions on the particular case. It may become a practical proposition to take up a satisfactory position and ride the storm out, letting the bad weather move past the vessel. When making the decision on the type of evasive action to take, Masters should bear in mind that tropical storms have a general tendency to move towards the pole of whichever hemisphere the vessel is navigating in. This, of course, is not inevitable, and a storm has been known to double back on itself more than once.

Setting an evasive course towards the equator when on the predicted track of the storm would seem to be the soundest action, provided that the storm maintains its predicted movements.

ICE TERMINOLOGY

Anchor Ice

Submerged ice attached or secured to the bottom is known as anchor ice.

Bare Ice

Ice without any snow covering.

Bergy Bit

A large piece of floating ice, this is between 1 m and 5 m above the surface of the water.

Brash Ice

An accumulation of broken, floating ice, this contains pieces up to approximately 2 m across.

Compact Pack Ice

A heavy concentration of pack ice, when no water is visible.

Compacted Ice Edge

A clear cut ice edge, this is generally found on the windward side of an area of pack ice, compacted by the action of wind or current.

Concentration

A ratio expressing the density of ice accumulation, concentration is expressed in tenths or oktas of the total area.

Consolidated Pack Ice

A concentration of 10/10, where the ice floes are frozen together.

Crack

This is a split or fracture in the ice surface, which has not parted.

Difficult Area

A general term used to describe the area as difficult for purpose of navigation.

Easy Area

A general term used to describe the area as not too difficult for the purpose of navigation.

Fast Ice

This is sea ice which has become 'fast' to the shore, ice wall or other similar surface. It may be formed by the freezing of sea water close

inshore or by pack ice freezing to the shore or other surfaces. Should its height extend more than 2 m, it would be referred to as an 'ice shelf'.

First Year Ice

A term derived from young ice, being sea ice of not more than one winter's growth, this ice is between 30 cm and 2 m thick.

Flaw

A narrow dividing section between the pack ice and fast ice, a flaw is formed by the shearing of the former from the latter.

Floating Ice

This general term is also used with regard to grounded or stranded ice.

Floe

This is a flat piece of ice more than 20 m across. Floes are sub-divided according to size as giant, vast, big, medium and small.

Floeberg

A massive piece of sea ice, a floeberg made up of one or more hummocks frozen together, the whole being separated from any other surrounding ice.

Fracture

This general term is used to describe any fracture/break of unspecified length. The width of the break is called:

large when over 500 m,
medium when 200–500 m,
small when 50–200 m, and
very small when less than 50 m.

Glacier

A continuously moving mass of snow and ice, a glacier moves from high to lower ground or, when afloat, its mass is continuously spreading.

Glacierberg

An iceberg of irregular shape is given this name.

Grey Ice

Young ice up to 15 cm in thickness, grey ice has a tendency to break up in a swell and will be seen to 'raft' under pressure.

Grounded Ice

Large or small pieces of ice gone aground/ashore in shoal water.



17. Small iceberg in open water of North Atlantic (1984).

Growler

This piece of ice shows less than 1 m above the surface of the water. Its volume is less than that of a 'bergy bit', and it usually has an area of approximately 20 sq. m. As a growler makes a very poor radar target, it is often very dangerous to navigation.

Hummock

A build-up of ice forced up by pressure is called a hummock, and a similar build-up of broken ice forced downwards by pressure is referred to as a 'bummock'.

Ice Belt

A long pack ice feature, an ice belt is longer than it is wide. Length will vary from about half a mile (1 km approx.) to more than 62 miles (100 km).

Ice Bound

When navigation in or out of a harbour is restricted by an accumulation of ice, the harbour is said to be 'ice bound'.

Ice Cake

A flat piece or cake of sea ice, less than 20 m across.

Ice Edge

This may be described as the dividing line between the open sea and the limit of sea ice (ice boundary).

Ice Field

Pack ice, composed of various sized floes in close proximity over an unspecified distance greater than 10 km across (6.2 miles), is called an ice field.

Ice-Free

Open water, clear of any ice, is ice-free.

Ice Patch

A quantity of pack ice, less than 10 km across (6.2 miles), is an ice patch.

Ice Shelf

This is a very thick layer of ice. An ice shelf could be up to 50 m above the surface of the water, and of any length. The seaward edge is termed an ice front.

Ice Tongue

A major ice projection from the coastline, this comprises several icebergs joined by 'fast ice'. Some or all of the icebergs may be grounded.

Iceberg

An enormous piece of ice more than 5 m in height above the surface of the water, an iceberg originates from a glacier and may be afloat or aground. When afloat, the greatest volume of the iceberg is beneath the surface.

Lead

This is a visible fracture or passage which is navigable by surface craft through the ice regions.

Level Ice

Flat sea ice unaffected by deformation is called level ice.

Multi-year Ice

This is ice which has survived for more than two summers without melting. Its thickness is variable but generally up to about 3 m. It is also practically salt-free.

New Ice

This term describes newly formed ice.

Nilas

A crust of thin ice approximately 10 cm in thickness, this often bends with the swell and wave motion on the surface. It may be sub-divided into dark nilas and light nilas.

Nip

The vessel is said to be nipped when ice under pressure is pressed into the ship's side; she is sometimes damaged in the process.

Open Pack Ice

This is a concentration of pack ice, of between four and six tenths coverage with extensive leads and floes not in contact with each other.

Open Water

This term describes clear water free of obstruction ice and navigable to surface craft, with ice concentration not exceeding one-tenth.

Pack Ice

A general term to include areas of sea ice, it does not include 'fast ice'.

Pancake Ice

Circular pieces of ice up to 3 m in diameter and about 10 cm in thickness, pancake ice curls up at the edges when pieces crash into each other.

Rafted Ice

This is deformed ice caused by layers riding on top of each other. Pressure changes cause the overriding, which is more often found in young ice.

Rotten Ice

This is ice in an advanced state of decomposition, usually consisting of light small pieces breaking up continuously.

Sea Ice

Ice formed from freezing sea water, found at sea, is called sea ice.

Stranded Ice

This is ice left ashore by a falling tide.

Tabular Berg

A flat-topped iceberg in the southern hemisphere.

Very Close Pack Ice

A concentration of pack ice between nine- and ten-tenths coverage is described by this term.

ICE NAVIGATION

In general, when a vessel has to advance through ice areas, the progress of the ship will be dependent on:

- (a) The nature of the ice.
- (b) The qualities of the vessel, scantlings, ice breaker bow construction, and motive power of machinery.
- (c) Expertise and experience of the Master.
- (d) Operational qualities of navigational instruments.
- (e) Assistance of tugs or ice breaker vessels.
- (f) Ice convoy facilities.

The Master of any vessel coming up to or approaching dangerous ice is obliged by the International Convention for the Safety of Life at Sea, 1960, to report any dangerous ice formation sighted on or near his course. His ice report should contain the following information: type of ice encountered; position of this ice; and GMT and date of sighting the same. The Master is further obliged to proceed at a moderate speed or alter his course to pass clear of ice dangers.

Ice reports are despatched to the International Ice Patrol, operated by the United States Coast Guard throughout the ice season, usually beginning about February and ending about June/July.

The prime function of the Ice Patrol is to warn shipping of the extent of sea ice and icebergs which may affect vessels on the main shipping routes.

Ice reports from shipping, together with weather reports from shipping, assist the Ice Patrol to piece together any movement of ice, and allow the construction of a facsimile chart of conditions for general broadcast to all shipping within the area. Reports are made by the Ice Patrol twice daily, together with the despatch of the facsimile chart. Additional reports of ice sightings are broadcast whenever considered necessary. Transmitting stations, together with frequencies and channels, are as described in the *Admiralty List of Radio Signals* (see p. 10). Mariners should be aware that this service is provided for them, and is greatly enhanced by their own co-operation. Reports of actual sightings help the flight planning of Ice Patrol aircraft and in designating patrol areas for surface craft.

Operating in Ice

Mariners entering ice regions should take early action to seek up-to-date ice reports from the Ice Patrol, as distributed by the US Naval Oceanographic Office. Ice limits should then be marked on to navigational charts, and any particular hazards, such as single icebergs, being plotted. Course and speed of the vessel can then be adjusted accordingly, circumstances dictating the safest route. A lookout is essential during daylight hours, even in so-called good visibility.

Vessels without operational radar should be prepared to stop during the hours of darkness if the concentration of dangerous ice warrants such action, and should at any time proceed only at a safe speed. Ice reports should be continually obtained and charts updated in accordance

with the vessel's progress. A combination of fog and ice is not only a dangerous combination but unfortunately a common occurrence.

Vessels attempting to negotiate ice regions should be equipped with reliable engines and steering gear. It is an advantage if the ship is ice-strengthened or longitudinally framed, with an ice-breaker bow.

It has been found by experience that ship-handling in ice can be achieved by observing one or two basic principles:

1. The vessel must endeavour to keep moving into the ice and making headway. Even if the movement is only very slight, it must be maintained.
2. It is best for the vessel to move with the ice, not against it.
3. Maintain freedom to move, bearing in mind that excessive speed lends itself to ice damage.
4. The mariner will require a great deal of patience.

Should the vessel become trapped in the ice and held, bear in mind that freedom of movement is lost and the ship will then only move with the ice, going wherever the ice is going. Should the forward motion of the vessel be impeded, a movement astern should be considered as an option, while searching for another 'lead' through the pack ice or ice field. Continuous movement astern should be avoided because of the very real danger to rudder and propeller. Continuous plotting of the ship's position in confined waters is essential at this stage in order to keep the vessel clear of shoals and to prevent disorientation. Regular checks on compasses and prominent landmarks must be considered essential.

The alternatives open to the Master are limited in the event of his vessel becoming 'ice bound'. Owners may decide to re-route the vessel to another port, but, failing this, one or more of the following actions are advised:

1. Assemble with other ships for movement in an ice convoy, usually escorted by ice-breaker vessels.
2. Follow the track of an ice-breaker vessel, or ice-strengthened vessel towards destination.
3. If equipped with an ice-breaker bow and also ice-strengthened, attempt passage independently.
4. Before leaving port, add ice strengthening to the forepart of your own vessel. (This can be done relatively quickly by building a framework in the forepeak tanks out of pit prop beams, and covering or filling the whole tank area with concrete. This construction may later become permanent ballast for the vessel, as it is unlikely that it could be easily removed without drydocking and cutting into the shell plate.)

Ice Damage

The extent of any damage will depend on the condition of the ice the vessel is passing through. The mariner should be prepared to accept some damage to the vessel, while limiting the amount as much as possible.

Severe wear of the outer shell plating will be experienced at the waterline level, and for some height and depth above this level, according to the thickness of the ice the ship is passing through. All paint work on superstructures can be expected to flake and become badly pitted, especially if the temperature is continuously below freezing for any period.

Denting of shell plates in the bow area must be anticipated. The stem will be stripped clean of all paint and protective covering. The rudder and propeller area is extremely susceptible to ice damage from large floes passing down the ship's side and colliding with the upper area of the rudder and the rudder securing to the stock.

Lifeboat water tanks should be part emptied to avoid fracture. Steam lines should be drained. Lagging on pipes should be regularly checked for expected deterioration. Ballast tanks and fresh-water tanks should be inspected daily to prevent freezing over.



18. Pack ice conditions.

PREVENTING COLLISIONS AT SEA



Collisions, it is hardly necessary to say, are a major hazard, particularly in busy waters such as the English Channel. We shall list the International Regulations of the International Marine Organisation (of which the UK and USA are party to) interspersing them with numerous illustrations.

Marine students are advised that diagrams should, where appropriate, be enhanced by colour, as a self-teaching aid, which would facilitate learning.

INTERNATIONAL REGULATIONS FOR PREVENTING
COLLISIONS AT SEA, 1972
(as amended by Resolution A464(XII)) A626(15) A678(16) and A736(18)

PART A. GENERAL

RULE 1

Application

- (a) These Rules shall apply to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels.
- (b) Nothing in these Rules shall interfere with the operation of special rules made by an appropriate authority for roadsteads, harbours, rivers, lakes or inland waterways connected with the high seas and navigable by seagoing vessels. Such special rules shall conform as closely as possible to these Rules.
- (c) Nothing in these Rules shall interfere with the operation of any special rules made by the Government of any State with respect to additional station or signal lights, shapes or whistle signals for ships of war and vessels proceeding under convoy, or with respect to additional station or signal lights or shapes for fishing vessels engaged in fishing as a fleet. These additional station or signal lights, shapes or whistle signals shall, so far as possible, be such that they cannot be mistaken for any light, shape or signal authorized elsewhere under these Rules.
- (d) Traffic separation schemes may be adopted by the Organization for the purpose of these Rules.

- (e) Whenever the Government concerned shall determine that a vessel of special construction or purpose cannot comply fully with the provisions of any of these Rules with respect to the number, position, range or arc of visibility of lights or shapes, as well as to the disposition and characteristics of sound-signalling appliances, such vessels shall comply with such other provisions in regard to the number, position, range or arc of visibility of lights or shapes, as well as to the disposition and characteristics of sound-signalling appliances, as her Government shall have determined to be the closest possible compliance with these Rules in respect of that vessel.

RULE 2

Responsibility

- (a) Nothing in these Rules shall exonerate any vessel, or the owner, Master or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.
- (b) In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger.

RULE 3

General Definitions

For the purpose of these Rules, except where the context otherwise requires:

- (a) The word 'vessel' includes every description of water craft, including non-displacement craft and seaplanes, used or capable of being used as a means of transportation on water.
- (b) The term 'power-driven vessel' means any vessel propelled by machinery.
- (c) The term 'sailing vessel' means any vessel under sail provided that propelling machinery, if fitted, is not being used.
- (d) The term 'vessel engaged in fishing' means any vessel fishing with nets, lines, trawls or other fishing apparatus which restrict manoeuvrability, but does not include a vessel fishing with trolling lines or other fishing apparatus which do not restrict manoeuvrability.
- (e) The word 'seaplane' includes any aircraft designed to manoeuvre on the water.
- (f) The term 'vessel not under command' means a vessel which through some exceptional circumstances is unable to manoeuvre as required by these Rules and is therefore unable to keep out of the way of another vessel.
- (g) The term 'vessel restricted in her ability to manoeuvre' means a vessel which from the nature of her work is restricted in her ability to manoeuvre as required by these Rules and is therefore unable to keep out of the way of another vessel. The term 'vessels restricted in their ability to manoeuvre' shall include but not be limited to:
- (i) a vessel engaged in laying, servicing or picking up a navigation mark, submarine cable or pipeline;
 - (ii) a vessel engaged in dredging, surveying or underwater operations;
 - (iii) a vessel engaged in replenishment or transferring persons, provisions or cargo while underway;

- (iv) a vessel engaged in the launching or recovery of aircraft;
- (v) a vessel engaged in mine clearance operations;
- (vi) a vessel engaged in a towing operation such as severely restricts the towing vessel and her tow in their ability to deviate from their course.
- (h) The term 'vessel constrained by her draught' means a power-driven vessel which, because of her draught in relation to the available depth and width of navigable water, is severely restricted in her ability to deviate from the course she is following.
- (i) The word 'underway' means that a vessel is not at anchor, or made fast to the shore, or aground.
- (j) The words 'length' and 'breadth' of a vessel mean her length overall and greatest breadth.
- (k) Vessels shall be deemed to be in sight of one another only when one can be observed visually from the other.
- (l) The term 'restricted visibility' means any condition in which visibility is restricted by fog, mist, falling snow, heavy rainstorms, sandstorms or any other similar causes.

PART B. STEERING AND SAILING RULES

Section I. Conduct of vessels in any condition of visibility

RULE 4

Application

Rules in this Section apply in any condition of visibility.

RULE 5

Look-out

Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.

RULE 6

Safe Speed

Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions.

In determining a safe speed the following factors shall be among those taken into account:

- (a) By all vessels:
 - (i) the state of visibility;
 - (ii) the traffic density including concentrations of fishing vessels or any other vessels;
 - (iii) the manoeuvrability of the vessel with special reference to stopping distance and turning ability in the prevailing conditions;

- (iv) at night the presence of background light such as from shore lights or from back scatter of her own lights;
 - (v) the state of wind, sea and current, and the proximity of navigational hazards;
 - (vi) the draught in relation to the available depth of water.
- (b) Additionally, by vessels with operational radar:
- (i) the characteristics, efficiency and limitations of the radar equipment;
 - (ii) any constraints imposed by the radar range scale in use;
 - (iii) the effect on radar detection of the sea state, weather and other sources of interference;
 - (iv) the possibility that small vessels, ice and other floating objects may not be detected by radar at an adequate range;
 - (v) the number, location and movement of vessels detected by radar;
 - (vi) the more exact assessment of the visibility that may be possible when radar is used to determine the range of vessels or other objects in the vicinity.

RULE 7

Risk of Collision

- (a) Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist.
- (b) Proper use shall be made of radar equipment if fitted and operational, including long-range scanning to obtain early warning of risk of collision and radar plotting or equivalent systematic observation of detected objects.
- (c) Assumption shall not be made on the basis of scanty information, especially scanty radar information.
- (d) In determining if risk of collision exists the following considerations shall be among those taken into account:
 - (i) such risk shall be deemed to exist if the compass bearing of an approaching vessel does not appreciably change;
 - (ii) such risk may sometimes exist even when an appreciable bearing change is evident, particularly when approaching a very large vessel or a tow or when approaching a vessel at close range.

RULE 8

Action to Avoid Collision

- (a) Any action taken to avoid collision shall, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship.
- (b) Any alteration of course and/or speed to avoid collision shall, if the circumstances of the case admit, be large enough to be readily apparent to another vessel observing visually or by radar; a succession of small alterations of course and/or speed should be avoided.
- (c) If there is sufficient sea room, alteration of course alone may be the most effective action to avoid a close-quarters situation provided that it is made in good time, is substantial and does not result in another close-quarters situation.
- (d) Action taken to avoid collision with another vessel shall be such as to result in passing at a safe distance. The effectiveness of the action shall be carefully checked until the other vessel is finally past and clear.

- (e) If necessary to avoid collision or allow more time to assess the situation, a vessel shall slacken her speed or take all way off by stopping or reversing her means of propulsion.
- (f) (i) A vessel which, by any of these Rules, is required not to impede the passage or safe passage of another vessel shall, when required by the circumstances of the case, take early action to allow sufficient sea room for the safe passage of the other vessel.
- (ii) A vessel required not to impede the passage or safe passage of another vessel is not relieved of this obligation if approaching the other vessel so as to involve risk of collision and shall, when taking action, have full regard to the action which may be required by the Rules of this part.
- (iii) A vessel the passage of which is not to be impeded remains fully obliged to comply with the Rules of this part when the two vessels are approaching one another so as to involve risk of collision.

RULE 9

Narrow Channels

- (a) A vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable.
- (b) A vessel of less than 20 metres in length or a sailing vessel shall not impede the passage of a vessel which can safely navigate only within a narrow channel or fairway.
- (c) A vessel engaged in fishing shall not impede the passage of any other vessel navigating within a narrow channel or fairway.
- (d) A vessel shall not cross a narrow channel or fairway if such crossing impedes the passage of a vessel which can safely navigate only within such channel or fairway. The latter vessel may use the sound signal prescribed in Rule 34(d) if in doubt as to the intention of the crossing vessel.
- (e) (i) In a narrow channel or fairway when overtaking can take place only if the vessel to be overtaken has to take action to permit safe passing, the vessel intending to overtake shall indicate her intention by sounding the appropriate signal prescribed in Rule 34(c)(i). The vessel to be overtaken shall, if in agreement, sound the appropriate signal prescribed in Rule 34(c)(ii) and take steps to permit safe passing. If in doubt she may sound the signals prescribed in Rule 34(d).
- (ii) This Rule does not relieve the overtaking vessels of her obligation under Rule 13.
- (f) A vessel nearing a bend or an area of a narrow channel or fairway where other vessels may be obscured by an intervening obstruction shall navigate with particular alertness and caution and shall sound the appropriate signal prescribed in Rule 34(e).
- (g) Any vessel shall, if the circumstances of the case admit, avoid anchoring in a narrow channel.

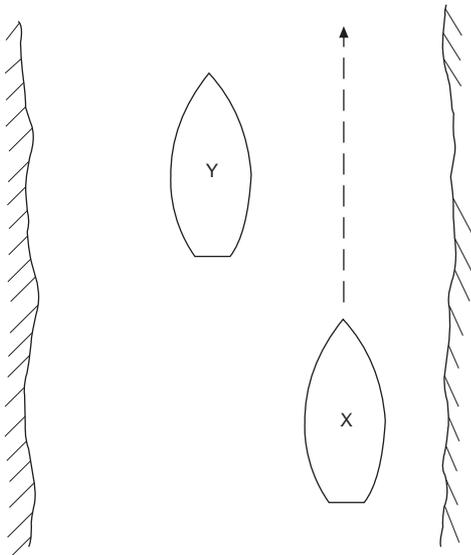


Figure 5.1 Overtaking vessel in a narrow channel.

AUTHOR'S COMMENTS

The intention of 'X' is to overtake vessel 'Y'.

It is the obligation of 'X' to keep out of the way of the vessel being overtaken, under Rule 13. Where an obvious clear passage exists, the overtaking operation may take place. No sound signals need be given by either vessel, because there

is no requirement for the vessel being overtaken to alter her course or speed or change her intended actions in any way whatsoever.

Under Rule 9 the overtaking vessel need only give the appropriate sound signals prescribed by Rules 34(c) and 34(d), when vessel 'Y' is required to alter her position to allow safe passage. Rule 9 does not apply to lanes of traffic separation schemes, even though such lanes may be relatively narrow (see Rule 10).

Sources of reference: Rules 9, 13, 17 and 34.

The intention of vessel 'X' is to overtake, and pass vessel 'Y', on the starboard side of vessel 'Y'. Vessel 'X' should indicate her intention by two prolonged blasts, followed by one short blast to mean 'I intend to overtake you on your starboard side'. Vessel 'Y' should answer only if she agrees to the operation taking place by sounding one prolonged, one short, one prolonged and one short blast in succession. If vessel 'Y' does not agree with the operation, she should sound no signal at all at this stage. Should doubt arise on vessel 'Y' after some movement by vessel 'X', vessel 'Y' may indicate such doubt by sounding at least five short and rapid blasts.

Sources of reference: Rules 9, 13, 17 and 34.

The intention of vessel 'X' is to overtake vessel 'Y' in a narrow channel by passing down the port side of vessel 'Y'. Vessel 'X' should indicate her intentions by two prolonged blasts, followed by two short blasts, to mean 'I intend to overtake you on your port side'. Vessel 'Y' should answer only if she agrees to the operation taking place by sounding one prolonged, one short, one prolonged and one short blast in succession. If vessel 'Y' does not agree with the operation, she should sound no signal at all at this stage. Should doubt arise on vessel 'Y' after some movement by vessel 'X', vessel 'Y' may indicate such doubt by sounding at least five short and rapid blasts.

Sources of reference: Rules 9, 13, 17 and 34.

Comment

Interpretation of the sound signals prescribed by Rule 34(c), and 34(d) being made in conjunction with vessels navigating in narrow channels (Rule 9) are open to considerable debate. In the author's view, doubt will only be created by the overtaking vessel if she starts to overtake without the agreement of the vessel to be overtaken.

There would appear to be a strong case for the vessel being overtaken to be allowed to sound one prolonged followed by one short blast (N in the morse code) to indicate 'Negative, do not attempt to overtake', or even X in morse code to signify 'Stop carrying out your intentions and watch for my signals'. However, additional signals may only add confusion to what could become a period saturated by sound signals, causing unnecessary concern all round.

Some mariners may feel that the sounding of five short and rapid blasts should be interpreted by other vessels as the negative signal, but the author feels that this is an incorrect assumption. The signal should only be sounded if and when an incorrect movement by the overtaking vessel creates doubt on board the vessel being overtaken (see Figures 5.1 to 5.3).

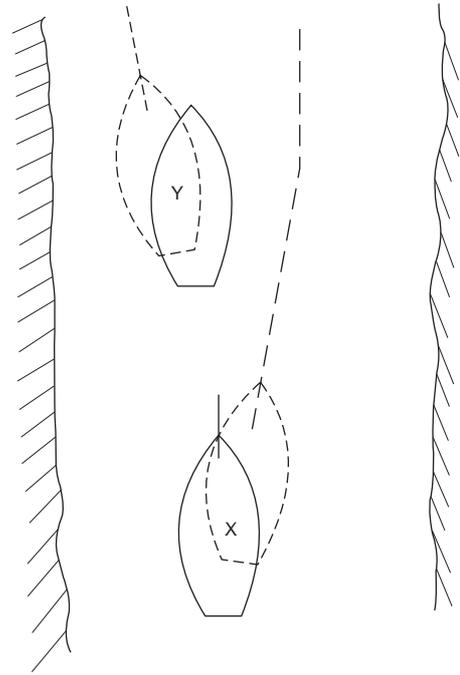


Figure 5.2 Overtaking vessels within the confines of a narrow channel.

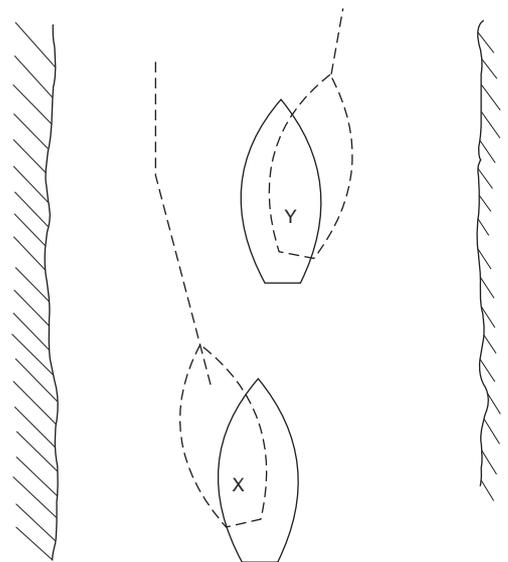


Figure 5.3

RULE 10

Traffic Separation Schemes

- (a) This Rule applies to traffic separation schemes adopted by the Organization and does not relieve any vessel of her obligation under any other Rule.
- (b) A vessel using a traffic separation scheme shall:
 - (i) proceed in the appropriate traffic lane in the general direction of traffic flow for that lane;
 - (ii) so far as practicable keep clear of a traffic separation line or separation zone,
 - (iii) normally join or leave a traffic lane at the termination of the lane, but when joining or leaving from either side shall do so at as small an angle to the general direction of traffic flow as practicable.
- (c) A vessel shall so far as practicable avoid crossing traffic lanes, but if obliged to do so shall cross on a heading as nearly as practicable at right angles to the general direction of traffic flow.
- (d)
 - (i) a vessel shall not use an inshore traffic zone when she can safely use the appropriate traffic lane within the adjacent traffic separation scheme. However, vessels of less than 20 metres in length, sailing vessels and vessels engaged in fishing may use the inshore traffic zone.
 - (ii) Notwithstanding sub-paragraph (d)(i), a vessel may use an inshore traffic zone when en route to or from a port, offshore installation or structure, pilot station or any other place situated within the inshore traffic zone; or to avoid immediate danger.
- (e) A vessel other than a crossing vessel or a vessel joining or leaving a lane shall not normally enter a separation zone or cross a separation line except:
 - (i) in cases of emergency to avoid immediate danger;
 - (ii) to engage in fishing within a separation zone.
- (f) A vessel navigating in areas near the terminations of traffic separation schemes shall do so with particular caution.
- (g) A vessel shall so far as practicable avoid anchoring in a traffic separation scheme or in areas near its terminations.
- (h) A vessel not using a traffic separation scheme shall avoid it by as wide a margin as is practicable.
- (i) A vessel engaged in fishing shall not impede the passage of any vessel following a traffic lane.
- (j) A vessel of less than 20 metres in length or a sailing vessel shall not impede the safe passage of a power-driven vessel following a traffic lane.
- (k) A vessel restricted in her ability to manoeuvre when engaged in an operation for the maintenance of safety of navigation in a traffic separation scheme is exempted from complying with this Rule to the extent necessary to carry out the operation.
- (l) A vessel restricted in her ability to manoeuvre when engaged in an operation for the laying, servicing or picking up of a submarine cable, within a traffic separation scheme, is exempted from complying with this Rule to the extent necessary to carry out the operation.

Section II. Conduct of vessels in sight of one another

RULE 11

Application

Rules in this Section apply to vessels in sight of one another.

RULE 12

Sailing Vessels

- (a) When two sailing vessels are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other as follows:
- (i) when each has the wind on a different side, the vessel which has the wind on the port side shall keep out of the way of the other;
 - (ii) when both have the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward;
 - (iii) if a vessel with the wind on the port side sees a vessel to windward and cannot determine with certainty whether the other vessel has the wind on the port or on the starboard side, she shall keep out of the way of the other.
- (b) For the purposes of this Rule the windward side shall be deemed to be the side opposite to that on which the mainsail is carried or, in the case of a square-rigged vessel, the side opposite to that on which the largest fore-and-aft sail is carried.

RULE 13

Overtaking

- (a) Notwithstanding anything contained in the Rules of Part B, Sections I and II any vessel overtaking any other shall keep out of the way of the vessel being overtaken.
- (b) A vessel shall be deemed to be overtaking when coming up with another vessel from a direction more than 22.5 degrees abaft her beam, that is, in such a position with reference to the vessel she is overtaking, that at night she would be able to see only the sternlight of that vessel but neither of her sidelights.
- (c) When a vessel is in any doubt as to whether she is overtaking another she shall assume that this is the case and act accordingly.
- (d) Any subsequent alteration of the bearing between the two vessels shall not make the overtaking vessel a crossing vessel within the meaning of these Rules or relieve her of the duty of keeping clear of the overtaken vessel until she is finally past and clear.

Comment

The target vessel is bearing exactly 2 points abaft the beam. The observing vessel must assume that it is a crossing situation, because the target is not, in the words of Rule 13, 'more than 22.5 degrees abaft her beam'. Vessel 'A' would normally be expected to give way to vessel 'B'. (To be an overtaking vessel, the target must be more than two points abaft the beam of your own vessel.)

If the observing vessel, namely your own ship, is in doubt as to the bearing of the other vessel and whether that vessel is an overtaking vessel, she must assume under Rule 7 that when risk of collision may exist, 'it does' exist, and take appropriate action to avoid collision (Rule 13c).

The target vessel is 'more' than 2 points abaft the beam of the vessel to be overtaken. The deciding factor making the target vessel an overtaking vessel is

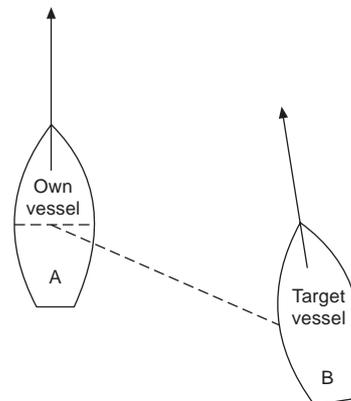


Figure 5.4 Illustration of Rule 13.

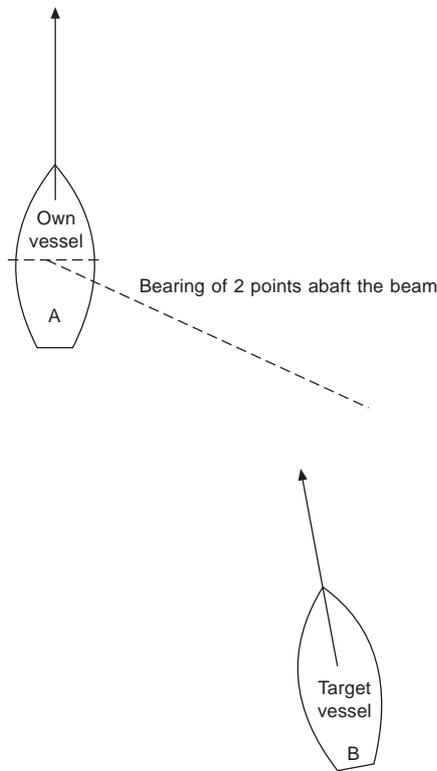


Figure 5.5 Overtaking under Rule 13.

the word 'more' written into Rule 13. Should any vessel be in doubt as to whether she is an overtaking vessel or a crossing vessel, she must assume herself to be an overtaking vessel and keep out of the way by acting accordingly.

RULE 14

Head-on Situation

- (a) When two power-driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision each shall alter her course to starboard so that each shall pass on the port side of the other.
- (b) Such a situation shall be deemed to exist when a vessel sees the other ahead or nearly ahead and by night she could see the mast head lights of the other in a line or nearly in a line and/or both sidelights and by day she observes the corresponding aspect of the other vessel.
- (c) When a vessel is in any doubt as to whether such a situation exists she shall assume that it does exist and act accordingly.

RULE 15

Crossing Situation

When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel.

RULE 16

Action by Give-way Vessel

Every vessel which is directed to keep out of the way of another vessel shall, so far as possible, take early and substantial action to keep well clear.

RULE 17

Action by Stand-on Vessel

- (a) (i) Where one of two vessels is to keep out of the way the other shall keep her course and speed.
- (ii) The latter vessel may however take action to avoid collision by her manoeuvre alone, as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action in compliance with these Rules.
- (b) When, from any cause, the vessel required to keep her course and speed finds herself so close that collision cannot be avoided by the action of the give-way vessel alone, she shall take such action as will best aid to avoid collision.
- (c) A power-driven vessel which takes action in a crossing situation in accordance with sub-paragraph (a)(ii) of this Rule to avoid collision with another power-driven vessel shall, if the circumstances of the case admit, not alter course to port for a vessel on her own port side.
- (d) This Rule does not relieve the give-way vessel of her obligation to keep out of the way.

RULE 18

Responsibilities Between Vessels

Except where Rules 9, 10 and 13 otherwise require:

- (a) A power-driven vessel underway shall keep out of the way of:
 - (i) a vessel not under command;
 - (ii) a vessel restricted in her ability to manoeuvre;
 - (iii) a vessel engaged in fishing;
 - (iv) a sailing vessel.
- (b) A sailing vessel underway shall keep out of the way of:
 - (i) a vessel not under command;
 - (ii) a vessel restricted in her ability to manoeuvre;
 - (iii) a vessel engaged in fishing.
- (c) A vessel engaged in fishing when underway shall, so far as possible, keep out of the way of:
 - (i) a vessel not under command;
 - (ii) a vessel restricted in her ability to manoeuvre.
- (d)
 - (i) Any vessel other than a vessel not under command or a vessel restricted in her ability to manoeuvre shall, if the circumstances of the case admit, avoid impeding the safe passage of a vessel constrained by her draught, exhibiting the signals in Rule 28;
 - (ii) A vessel constrained by her draught shall navigate with particular caution having full regard to her special condition.
- (e) A seaplane on the water shall, in general, keep well clear of all vessels and avoid impeding their navigation. In circumstances, however, where risk of collision exists, she shall comply with the Rules of this Part.

Section III. Conduct of vessels in restricted visibility

RULE 19

Conduct of Vessels in Restricted Visibility

- (a) This Rule applies to vessels not in sight of one another when navigating in or near an area of restricted visibility.
- (b) Every vessel shall proceed at a safe speed adapted to the prevailing circumstances and conditions of restricted visibility. A power-driven vessel shall have her engines ready for immediate manoeuvre.
- (c) Every vessel shall have due regard to the prevailing circumstances and conditions of restricted visibility when complying with the Rules of Section I of this Part.
- (d) A vessel which detects by radar alone the presence of another vessel shall determine if a close-quarters situation is developing and/or risk of collision exists. If so, she shall take avoiding action in ample time, provided that when such action consists of an alteration of course, so far as possible the following shall be avoided:
 - (i) an alteration of course to port for a vessel forward of the beam, other than for a vessel being overtaken;
 - (ii) an alteration of course towards a vessel abeam or abaft the beam.

- (e) Except where it has been determined that a risk of collision does not exist, every vessel which hears apparently forward of her beam the fog signal of another vessel, or which cannot avoid a close-quarters situation with another vessel forward of her beam, shall reduce her speed to the minimum at which she can be kept on her course. She shall if necessary take all her way off and in any event navigate with extreme caution until danger of collision is over.

PART C. LIGHTS AND SHAPES

RULE 20

Application

- (a) Rules in this Part shall be complied with in all weathers.
- (b) The Rules concerning lights shall be complied with from sunset to sunrise, and during such times no other lights shall be exhibited, except such lights as cannot be mistaken for the lights specified in these Rules or do not impair their visibility or distinctive character, or interfere with the keeping of a proper look-out.
- (c) The lights prescribed by these Rules shall, if carried, also be exhibited from sunrise to sunset in restricted visibility and may be exhibited in all other circumstances when it is deemed necessary.
- (d) The Rules concerning shapes shall be complied with by day.
- (e) The lights and shapes specified in these Rules shall comply with the provisions of Annex I to these Regulations.

RULE 21

Definitions

- (a) 'Masthead light' means a white light placed over the fore and aft centreline of the vessel showing an unbroken light over an arc of the horizon of 225 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on either side of the vessel.
- (b) 'Sidelights' means a green light on the starboard side and a red light on the port side each showing an unbroken light over an arc of the horizon of 112.5 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on its respective side. In a vessel of less than 20 metres in length the sidelights may be combined in one lantern carried on the fore and aft centreline of the vessel.
- (c) 'Sternlight' means a white light placed as nearly as practicable at the stern showing an unbroken light over an arc of the horizon of 135 degrees and so fixed as to show the light 67.5 degrees from right aft on each side of the vessel.
- (d) 'Towing light' means a yellow light having the same characteristics as the 'sternlight' defined in paragraph (c) of this Rule.
- (e) 'All-round light' means a light showing an unbroken light over an arc of the horizon of 360 degrees.
- (f) 'Flashing light' means a light flashing at regular intervals at a frequency of 120 flashes or more per minute.

RULE 22

Visibility of Lights

The lights prescribed in these Rules shall have an intensity as specified in Section 8 of Annex I to these Regulations so as to be visible at the following minimum ranges:

- (a) In vessels of 50 metres or more in length:
 - a masthead light, 6 miles;
 - a sidelight, 3 miles;
 - a sternlight, 3 miles;
 - a towing light, 3 miles;
 - a white, red, green or yellow all-round light, 3 miles.
- (b) In vessels of 12 metres or more in length but less than 50 metres in length:
 - a masthead light, 5 miles; except that where the length of the vessel is less than 20 metres, 3 miles;
 - a sidelight, 2 miles;
 - a sternlight, 2 miles;
 - a towing light, 2 miles;
 - a white, red, green or yellow all-round light, 2 miles.
- (c) In vessels of less than 12 metres in length:
 - a masthead light, 2 miles;
 - a sidelight, 1 mile;
 - a sternlight, 2 miles;
 - a towing light, 2 miles;
 - a white, red, green or yellow all-round light, 2 miles.
- (d) In inconspicuous partly submerged vessels or objects being towed:
 - a white all-round light, 3 miles.

A power-driven vessel less than 50 m in length need not show the second masthead light but may do so.

REFERENCE FIGURE 5.6

- A. Second light at least 4.5 m higher than foremast light.
- B. Forward light not less than 6 m high. If the breadth of the vessel exceeds 6 m, it should be at a height not less than such breadth, but need not be over a height of 12 m.
- C. Sidelight at a height not greater than three-quarters of that of the foremast light.
- X. Second light not less than half of the vessel's length away from foremast light, but need not be more than 100 m.
- Y. Foremast light not more than a quarter of the vessel's length from the stem.

Source of references: Rules 21, 22, 23, Annex 1, Statutory Instrument 1983 No. 708.

Sidelights

Range	3 miles
Arc	112 ¹ / ₂ °

Mainmast/foremast

Range	6 miles
Arc	225°

Stern light

Range	3 miles
Arc	135°

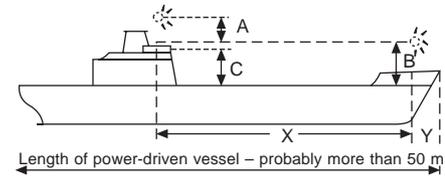


Figure 5.6 Navigation lights under Rule 23.

For power-driven vessel of 50 m or more in length

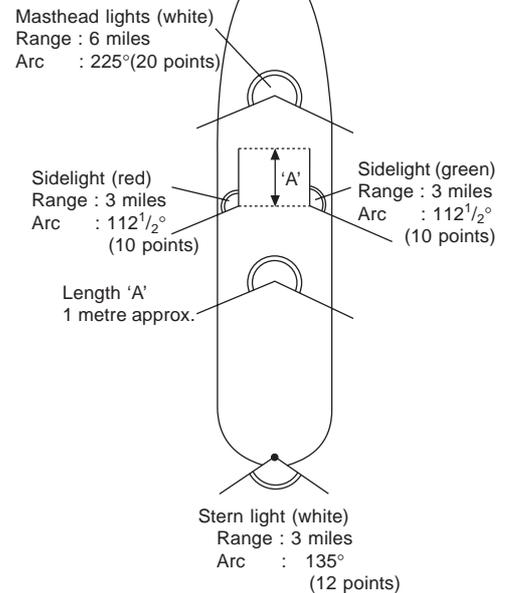


Figure 5.7 Arcs and ranges of lights for power-driven vessel.

Sources of reference: Rules 21 and 22, Annex 1, and Surveyors' Instructions.

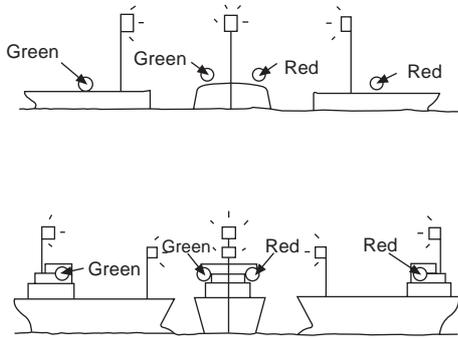


Figure 5.8 Power-driven vessel's lights as seen at night, or in any condition of restricted or poor visibility or whenever it is deemed necessary.

RULE 23

Power-driven Vessels Underway

- (a) A power-driven vessel underway shall exhibit:
 - (i) a masthead light forward;
 - (ii) a second masthead light abaft of and higher than the forward one; except that a vessel of less than 50 metres in length shall not be obliged to exhibit such light but may do so;
 - (iii) sidelights;
 - (iv) a sternlight.
- (b) An air-cushion vessel when operating in the non-displacement mode shall, in addition to the lights prescribed in paragraph (a) of this Rule, exhibit an all-round flashing yellow light.
- (c)
 - (i) A power-driven vessel of less than 12 metres in length may in lieu of the lights prescribed in paragraph (a) of this Rule exhibit an all-round white light and sidelights;
 - (ii) a power-driven vessel of less than 7 metres in length whose maximum speed does not exceed 7 knots may in lieu of the lights prescribed in paragraph (a) of this Rule exhibit an all-round white light and shall, if practicable, also exhibit sidelights;
 - (iii) the masthead light or all-round white light on a power-driven vessel of less than 12 metres in length may be displaced from the fore and aft centreline of the vessel if centreline fitting is not practicable, provided that the sidelights are combined in one lantern which shall be carried on the fore and aft centreline of the vessel or located as nearly as practicable in the same fore and aft line as the masthead light or the all-round white light.

Above, more than 12 m in length but less than 50 m, masthead light 5 miles (may be 3 miles if vessel's length less than 20 m), sidelights 2 miles, stern light 2 miles (not shown in diagram).

Below, under way, but not necessarily making way, masthead light forward and second masthead light higher and abaft this forward light. (A vessel of less than 50 m in length need not show this second masthead light, but may do so if desired.) Range of masthead lights 6 or 5 miles, sidelights 3 or 2 miles, stern light 3 or 2 miles (not shown in this diagram).

Sources of reference: Rules 22 and 23.

Each arc of the combined lantern must show from right ahead to 2 points abaft the vessels beam ($112\frac{1}{2}^\circ$). Range 2 miles or, if vessel less than 12 m, 1 mile.

Above, power-driven vessel less than 20 m in length showing the sidelights in a combined lantern on the fore and aft line. Stern light arc of visibility over 12 points of the compass, (135°), range 2 miles.

Below, power-driven vessel less than 7 m in length whose maximum speed does not exceed 7 knots.

Small-boat owners should be aware that if practical their boats should also exhibit sidelights. Screens need not be fitted to the combined lantern when complying with the specifications of Annex 1.

Sources of reference: Rules 20, 21, 22, 23, and Annex 1.

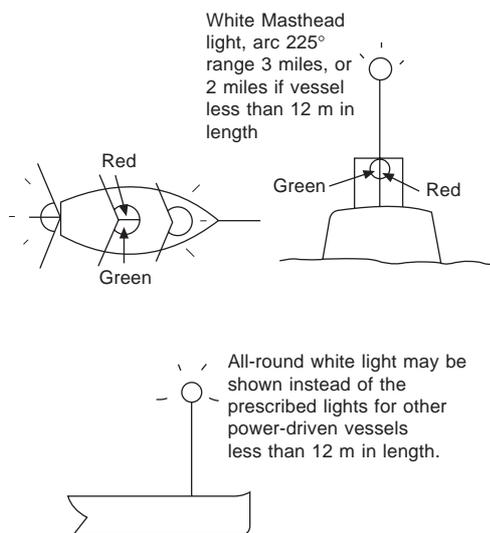


Figure 5.9 Small power-driven vessels – combined lantern.

RULE 24

Towing and Pushing

- (a) A power-driven vessel when towing shall exhibit:
 - (i) instead of the light prescribed in Rule 23(a)(i) or (a)(ii), two masthead lights in a vertical line. When the length of the tow, measuring from the stern of the towing vessel to the after end of the tow exceeds 200 metres, three such lights in a vertical line;
 - (ii) sidelights;
 - (iii) a sternlight;
 - (iv) a towing light in a vertical line above the sternlight;
 - (v) when the length of the tow exceeds 200 metres, a diamond shape where it can best be seen.
- (b) When a pushing vessel and a vessel being pushed ahead are rigidly connected in a composite unit they shall be regarded as a power-driven vessel and exhibit the lights prescribed in Rule 23.
- (c) A power-driven vessel when pushing ahead or towing alongside, except in the case of a composite unit, shall exhibit:
 - (i) instead of the light prescribed in Rule 23(a)(i) or (a)(ii), two masthead lights in a vertical line;
 - (ii) sidelights;
 - (iii) a sternlight.
- (d) A power-driven vessel to which paragraph (a) or (c) of this Rule apply shall also comply with Rule 23(a)(ii).
- (e) A vessel or object being towed, other than those mentioned in paragraph (g) of this Rule, shall exhibit:
 - (i) sidelights;
 - (ii) a sternlight;
 - (iii) when the length of the tow exceeds 200 metres, a diamond shape where it can best be seen.
- (f) Provided that any number of vessels being towed alongside or pushed in a group shall be lighted as one vessel:
 - (i) a vessel being pushed ahead, not being part of a composite unit, shall exhibit at the forward end, sidelights;
 - (ii) a vessel being towed alongside shall exhibit a sternlight and at the forward end, sidelights.
- (g) An inconspicuous, partly submerged vessel or object, or combination of such vessels or objects being towed, shall exhibit:
 - (i) if it is less than 25 metres in breadth, one all-round white light at or near the forward end and one at or near the after end except that dracones need not exhibit a light at or near the forward end;
 - (ii) if it is 25 metres or more in breadth, two additional all-round white lights at or near the extremities of its breadth;
 - (iii) if it exceeds 100 metres in length, additional all-round white lights between the lights prescribed in sub-paragraphs (i) and (ii) so that the distance between the lights shall not exceed 100 metres;
 - (iv) a diamond shape at or near the aftermost extremity of the last vessel or object being towed and if the length of the tow exceeds 200 metres an additional diamond shape where it can best be seen and located as far forward as is practicable.
- (h) Where from any sufficient cause it is impracticable for a vessel or object being towed to exhibit the lights or shapes prescribed in paragraph (e) or

- (g) of this Rule, all possible measures shall be taken to light the vessel or object towed or at least to indicate the presence of such vessel or object.
- (i) Where from any sufficient cause it is impracticable for a vessel not normally engaged in towing operations to display the lights prescribed in paragraph (a) or (c) of this Rule, such vessel shall not be required to exhibit those lights when engaged in towing another vessel in distress or otherwise in need of assistance. All possible measures shall be taken to indicate the nature of the relationship between the towing vessel and the vessel being towed as authorized by Rule 36, in particular by illuminating the towline. A vessel engaged in towing operations that render her unable to deviate from her course shall, in addition to the black diamond day signal or the towing lights at night, exhibit the lights or shapes for a vessel restricted in her ability to manoeuvre.

Sources of reference: Rules 3, 24, 27 and Annex 1.

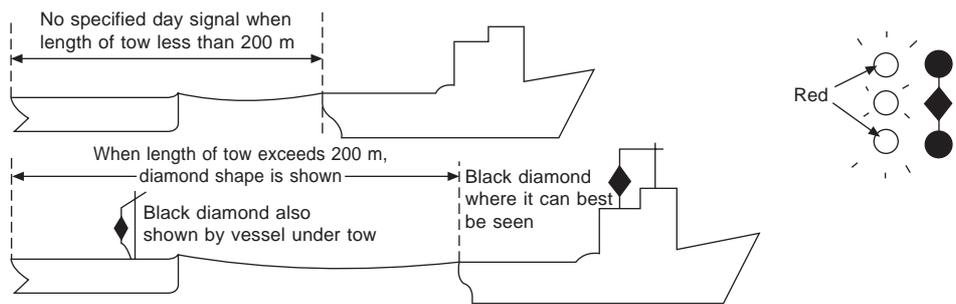


Figure 5.10 Towing.

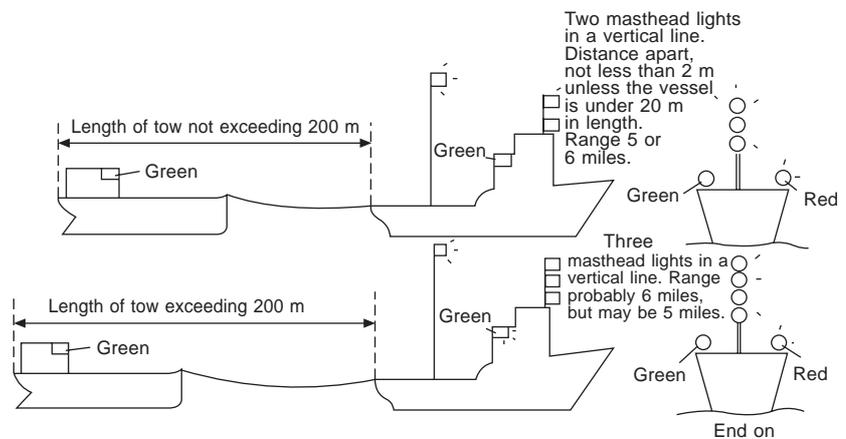
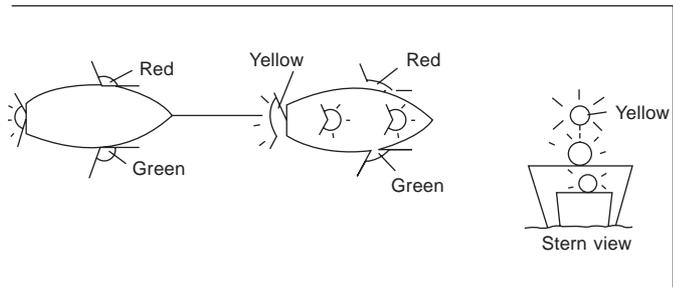
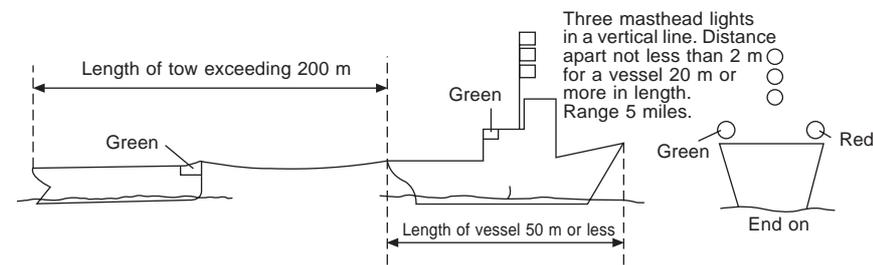


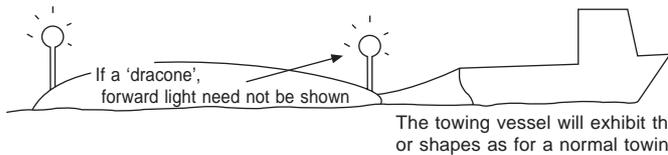
Figure 5.11 Towing.



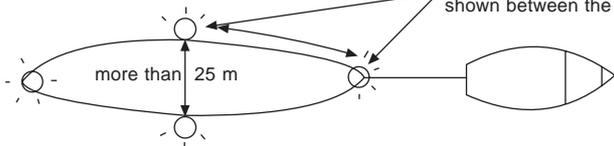
Ref., Source; Rules, 21, 22, 24. Annex 1

Figure 5.12 Towing.

if the object being towed is less than 25 m in breadth, one all-round white light aft, one all-round white light forward.



Plan view, partly submerged object being towed, breadth of object being greater than 25 m.



The object must exhibit, at or near its extremities, two additional all-round white lights. By day any partially submerged object should exhibit at or near the aftermost extremity a black diamond and should the length of tow exceed 200 m, an additional diamond located as far forward as practical.

Figure 5.13 Vessels towing inconspicuous, partly submerged objects.

Mariners should exercise extreme caution when identifying a tug and tow, bearing in mind that a tug less than 50 m in length with a tow exceeding 200 m in length will show similar lights to a larger tug with a tow of less than 200 m, when seen end-on.

Sources of reference: Rules 21, 22, 24, and Annex 1.

The towing light is to provide a reference point to assist the tow to steer by, and provide identification for other vessels approaching from astern. It must be shown by all power-driven vessels when engaged in towing.

Sources of reference: Rules 21, 22, 24 and Annex 1.

The pushing vessel will exhibit two masthead lights in a vertical line in the forward part, together with sidelights and stern light.

The vessel or unit being pushed will exhibit sidelights forward.

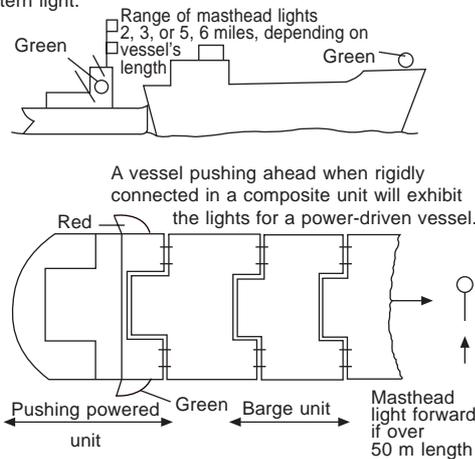


Figure 5.14 Above, power-driven vessel engaged in pushing operations when not rigidly connected. Below, power-driven vessel pushing ahead when rigidly connected.

RULE 25

Sailing Vessels Underway and Vessels Under Oars

- (a) A sailing vessel underway shall exhibit:
 - (i) sidelights;
 - (ii) a sternlight.
- (b) In a sailing vessel of less than 20 metres in length the lights prescribed in paragraph (a) of this Rule may be combined in one lantern carried at or near the top of the mast where it can best be seen.
- (c) A sailing vessel underway may, in addition to the lights prescribed in paragraph (a) of this Rule, exhibit at or near the top of the mast, where they can best be seen, two all-round lights in a vertical line, the upper being red and the lower green, but these lights shall not be exhibited in conjunction with the combined lantern permitted by paragraph (b) of this Rule.
- (d)
 - (i) A sailing vessel of less than 7 metres in length shall, if practicable, exhibit the lights prescribed in paragraph (a) or (b) of this Rule, but if she does not, she shall have ready at hand an electric torch or lighted lantern showing a white light which shall be exhibited in sufficient time to prevent collision.
 - (ii) A vessel under oars may exhibit the lights prescribed in this Rule for sailing vessels, but if she does not, she shall have ready at hand an electric torch or lighted lantern showing a white light which shall be exhibited in sufficient time to prevent collision.
- (e) A vessel proceeding under sail when also being propelled by machinery shall exhibit forward where it can best be seen a conical shape, apex downwards.

RULE 26

Fishing Vessels

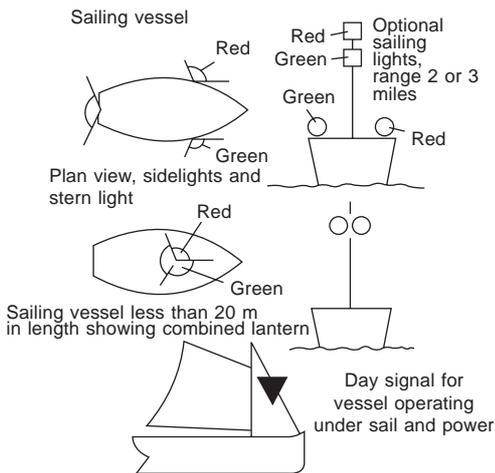


Figure 5.15 Distinguishing lights and shape for vessel under sail and under combined sail and power.

- (a) A vessel engaged in fishing, whether underway or at anchor, shall exhibit only the lights and shapes prescribed in this Rule.
- (b) A vessel when engaged in trawling, by which is meant the dragging through the water of a dredge net or other apparatus used as a fishing appliance, shall exhibit:
 - (i) two all-round lights in a vertical line, the upper being green and the lower white, or a shape consisting of two cones with their apexes together in a vertical line one above the other;
 - (ii) a masthead light abaft of and higher than the all-round green light; a vessel of less than 50 metres in length shall not be obliged to exhibit such a light but may do so;
 - (iii) when making way through the water, in addition to the lights prescribed in this paragraph, sidelights and a sternlight.
- (c) A vessel engaged in fishing, other than trawling, shall exhibit:
 - (i) two all-round lights in a vertical line, the upper being red and the lower white, or a shape consisting of two cones with apexes together in a vertical line one above the other;
 - (ii) when there is outlying gear extending more than 150 metres horizontally from the vessel, an all-round white light or a cone apex upwards in the direction of the gear;

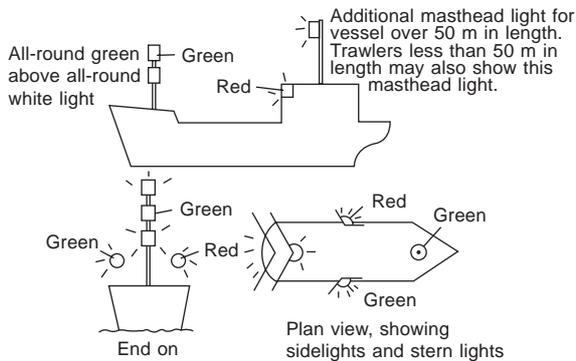


Figure 5.16 Lights on trawler engaged in fishing at night.

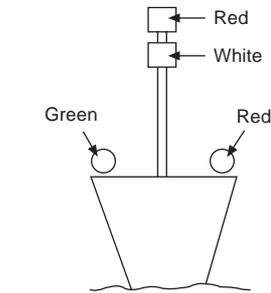
- (iii) when making way through the water, in addition to the lights prescribed in this paragraph, sidelights and a sternlight.
- (d) The additional signals described in Annex II to these Regulations apply to a vessel engaged in fishing in close proximity to other vessels engaged in fishing.
- (e) A vessel when not engaged in fishing shall not exhibit the lights or shapes prescribed in this Rule, but only those prescribed for a vessel of her length.

RULE 27

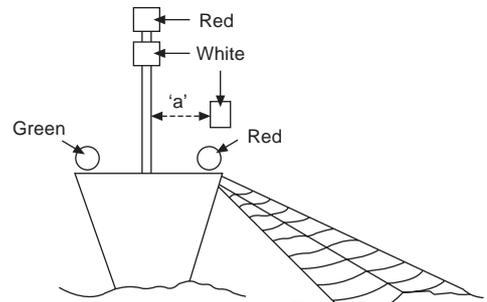
Vessels not under Command or Restricted in their Ability to Manoeuvre

- (a) A vessel not under command shall exhibit:
 - (i) two all-round red lights in a vertical line where they can best be seen;
 - (ii) two balls or similar shapes in a vertical line where they can best be seen;
 - (iii) when making way through the water, in addition to the lights prescribed in this paragraph, sidelights and a sternlight.
- (b) A vessel restricted in her ability to manoeuvre, except a vessel engaged in mine clearance operations, shall exhibit:
 - (i) three all-round lights in a vertical line where they can best be seen. The highest and lowest of these lights shall be red and the middle light shall be white;
 - (ii) three shapes in a vertical line where they can best be seen. The highest and lowest of these shapes shall be balls and the middle one a diamond;
 - (iii) when making way through the water, a masthead light or lights, sidelights and a sternlight, in addition to the lights prescribed in sub-paragraph (i);
 - (iv) when at anchor, in addition to the lights or shapes prescribed in sub-paragraphs (i) and (ii), the light, lights or shape prescribed in Rule 30.

Figure 5.18 Fishing vessel's day signals.
Sources of reference: Rule 26 and Annex 1, Section 6.

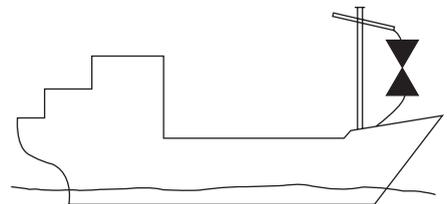


A vessel engaged in fishing, but not trawling, where the nets do not extend more than 150 m into the sea.

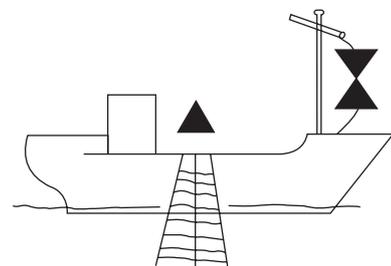


A vessel engaged in fishing with nets or lines extending over the port side more than 150 m into the sea. Distance 'a' not less than 2 m and not more than 6 m.

Figure 5.17 Fishing vessel other than a trawler at night.
Sources of reference: Rule 26 and Annex 1 Section 4a.



A vessel of unspecified length engaged in fishing.



A vessel engaged in fishing with nets or lines extending more than 150 metres into the sea, with starboard side exhibiting a single cone apex up in the direction of the extending gear.

- (c) A power-driven vessel engaged in a towing operation such as severely restricts the towing vessel and her tow in their ability to deviate from their course shall, in addition to the lights or shapes prescribed in Rule 24 (a), exhibit the lights or shapes prescribed in sub-paragraphs (b)(i) and (ii) of this Rule.
- (d) A vessel engaged in dredging or underwater operations, when restricted in her ability to manoeuvre, shall exhibit the lights and shapes prescribed in sub-paragraphs (b)(i), (ii) and (iii) of this Rule and shall in addition, when an obstruction exists, exhibit:
 - (i) two all-round red lights or two balls in a vertical line to indicate the side on which the obstruction exists;
 - (ii) two all-round green lights or two diamonds in a vertical line to indicate the side on which another vessel may pass;
 - (iii) when at anchor, the lights or shapes prescribed in this paragraph instead of the lights or shape prescribed in Rule 30.
- (e) Whenever the size of a vessel engaged in diving operations makes it impracticable to exhibit all lights and shapes prescribed in paragraph (d) of this Rule, the following shall be exhibited:
 - (i) three all-round lights in a vertical line where they can best be seen. The highest and lowest of these lights shall be red and the middle light shall be white;
 - (ii) a rigid replica of the International Code flag 'A' not less than 1 metre in height. Measures shall be taken to ensure its all-round visibility.
- (f) A vessel engaged in mine clearance operations shall in addition to the lights prescribed for a power-driven vessel in Rule 23 or to the lights or shape prescribed for a vessel at anchor in Rule 30 as appropriate, exhibit three all-round green lights or three balls. One of these lights or shapes shall be exhibited near the foremast head and one at each end of the fore yard. These lights or shapes indicate that it is dangerous for another vessel to approach within 1000 metres of the mine clearance vessel.
- (g) Vessels of less than 12 metres in length, except those engaged in diving operations, shall not be required to exhibit the lights and shapes prescribed in this Rule.
- (h) The signals prescribed in this Rule are not signals of vessels in distress and requiring assistance. Such signals are contained in Annex IV to these Regulations.

RULE 28

Vessels Constrained by their Draught

A vessel constrained by her draught may, in addition to the lights prescribed for power-driven vessels in Rule 23, exhibit where they can best be seen three all-round red lights in a vertical line, or a cylinder.

RULE 29

Pilot Vessels

- (a) A vessel engaged on pilotage duty shall exhibit:
 - (i) at or near the masthead, two all-round lights in a vertical line, the upper being white and the lower red;

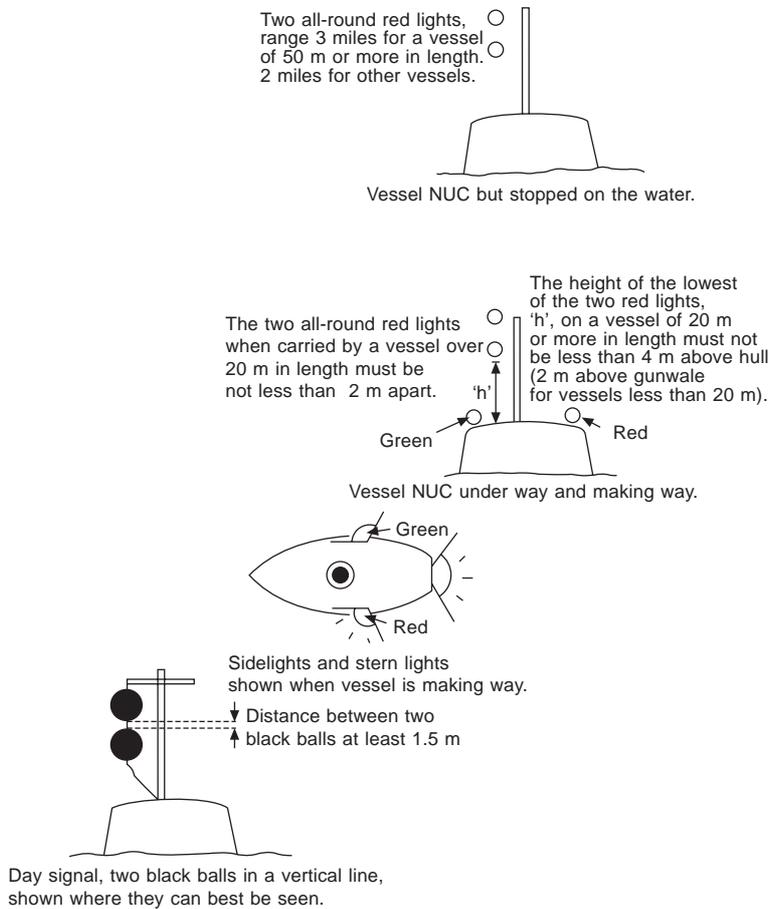


Figure 5.19 Vessel not under command (NUC).
Sources of reference: Rules 22, 27 and Annex 1, Section 6.

- (ii) when underway, in addition, sidelights and a sternlight;
 - (iii) when at anchor, in addition to the lights prescribed in sub-paragraph (i), the light, lights or shape prescribed in Rule 30 for vessels at anchor.
- (b) A pilot vessel when not engaged on pilotage duty shall exhibit the lights or shapes prescribed for a similar vessel of her length.

RULE 30

Anchored Vessels and Vessels Aground

- (a) A vessel at anchor shall exhibit where it can best be seen:
- (i) in the fore part, an all-round white light or one ball;
 - (ii) at or near the stern and at a lower level than the light prescribed in sub-paragraph (i), an all-round white light.
- (b) A vessel of less than 50 metres in length may exhibit an all-round white light where it can best be seen instead of the lights prescribed in paragraph (a) of this Rule.

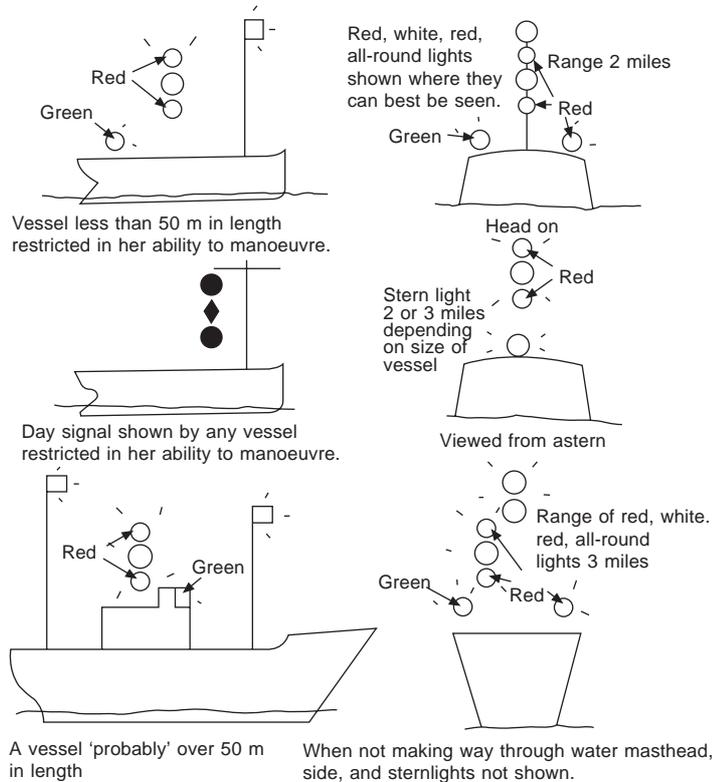


Figure 5.20 Vessel restricted in her ability to manoeuvre. Sources of reference: Rules 3, 21, 22, 27 and Annex 1.

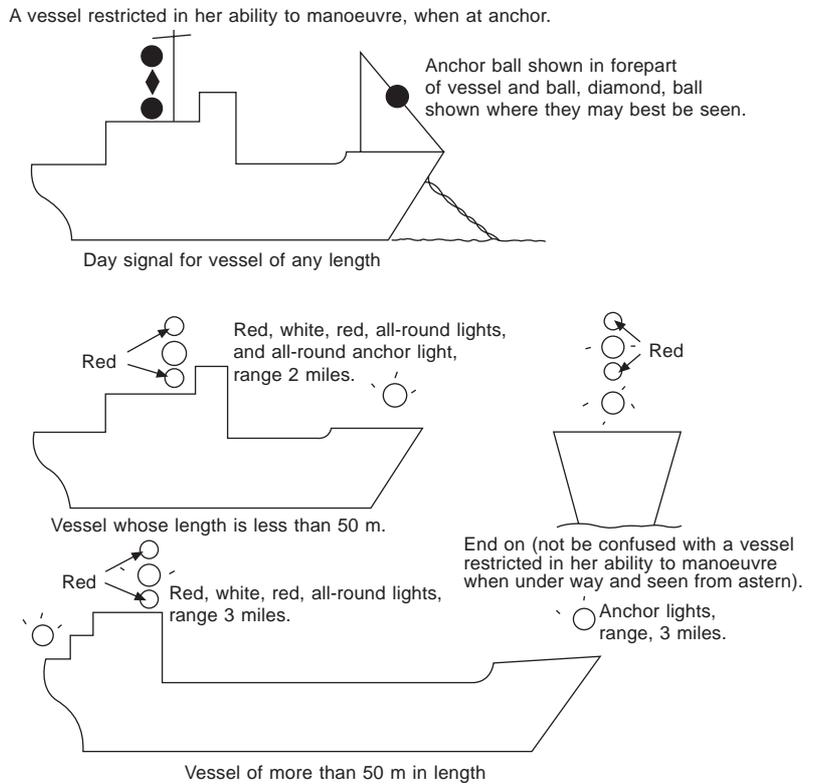
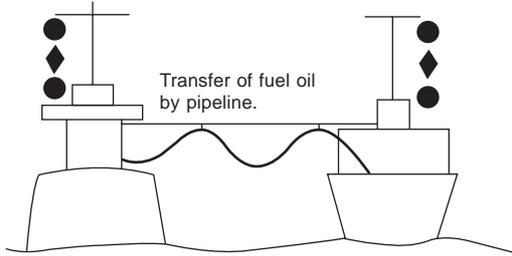
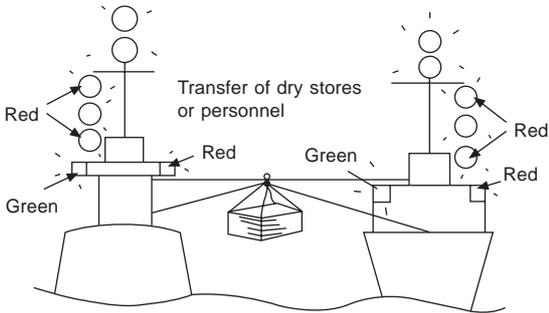


Figure 5.21 Vessel restricted in her ability to manoeuvre, when at anchor. Sources of reference: Rules 22, 27, 30 and Annex 1.

Two vessels in close proximity, day signal ball, diamond, ball, shown where they can best be seen.



Regular practice with warships where more than one vessel may be replenished at the same time.

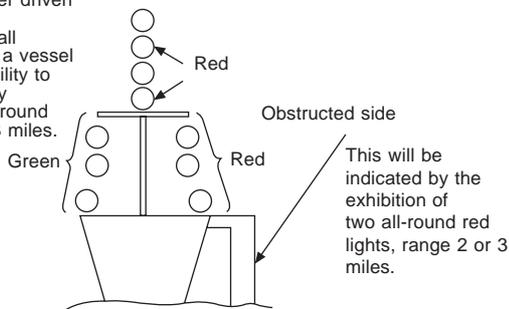


At night, all-round, red, white, red, lights, range 2 or 3 miles, depending on length of vessel under or over 50 m.

Figure 5.22 Vessels engaged in replenishment at sea, restricted in their ability to manoeuvre.

Sources of reference: Rules 3, 27, 36 and Annex 1.

The dredger will show masthead(s), side and stern lights as for a power driven vessel under way. In addition, she shall show the lights for a vessel restricted in her ability to manoeuvre, namely red, white, red, all-round lights, range 2 or 3 miles.



Dredger under way and making way through the water.

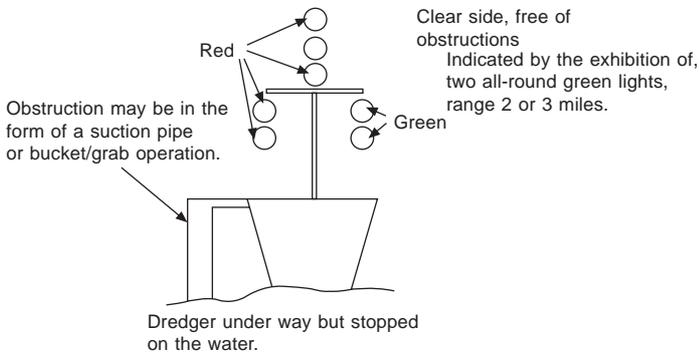


Figure 5.23 Vessel engaged in dredging or under water operations.

Sources of reference: Rules 3, 22 and 27.

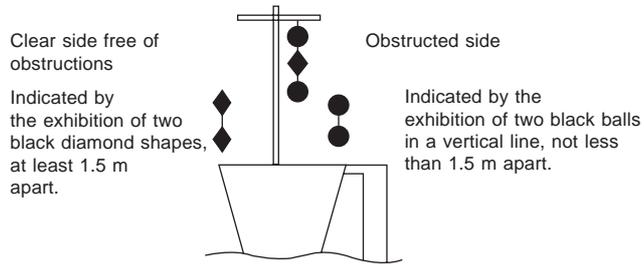


Figure 5.24 Vessel engaged in dredging operations by day.

Sources of reference: Rules 3, 27 and Annex 1.

A vessel engaged in dredging or underwater operations under way and making way, or stopped or at anchor – day signal as seen from right ahead or right astern.

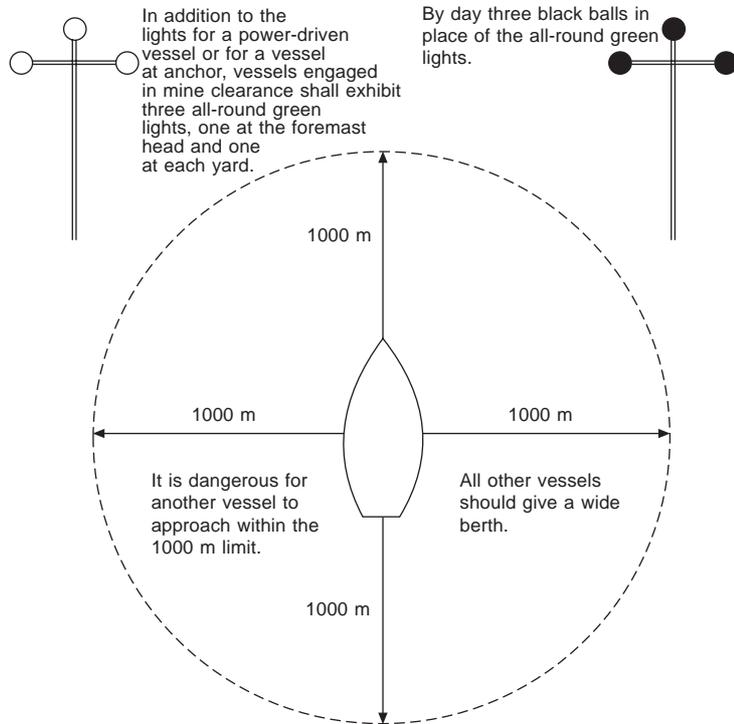


Figure 5.25 Mine clearance operations.

Sources of reference: Rules 3, 22, 27(f), 30 and Annex 1.

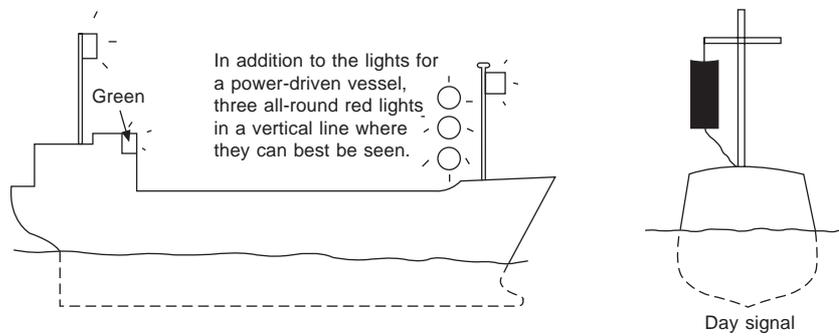


Figure 5.26 Vessel constrained by her draught.

Sources of reference; Rules 3, 22, 28 and Annex 1 Section 6(a)iii and b(b).

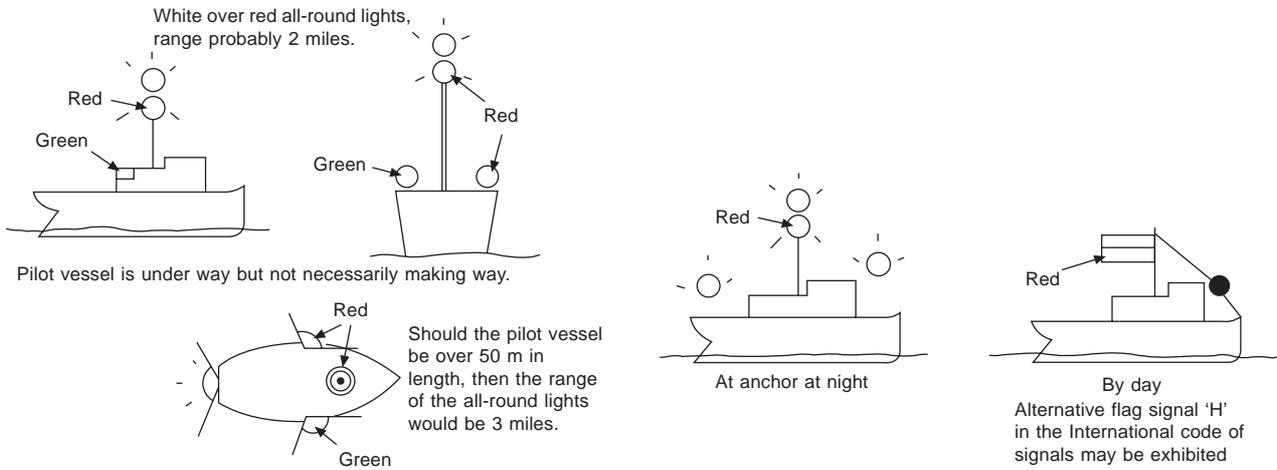


Figure 5.27 Pilot vessel engaged on pilotage duty.
Sources of reference: Rules 21, 22, 29, 30, 35(i) and Annex 1.

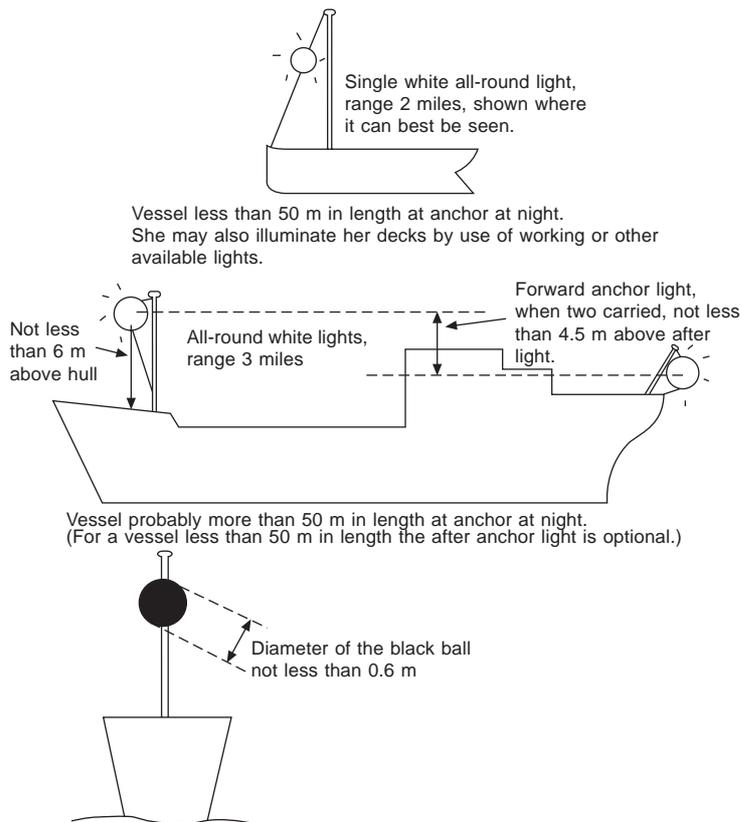


Figure 5.28 Vessel at anchor.
Sources of reference: Rules 22, 30, and Annex 1, Sections 2(k) and 6(a).

Day signal one black ball exhibited in the forepart of the vessel where it can best be seen.

- (c) A vessel at anchor may, and a vessel of 100 metres and more in length shall, also use the available working or equivalent lights to illuminate her decks.
- (d) A vessel aground shall exhibit the lights prescribed in paragraph (a) or (b) of this Rule and in addition, where they can best be seen:
 - (i) two all-round red lights in a vertical line;
 - (ii) three balls in a vertical line.
- (e) A vessel of less than 7 metres in length, when at anchor, not in or near a narrow channel, fairway or anchorage, or where other vessels normally navigate, shall not be required to exhibit the lights or shape prescribed in paragraphs (a) and (b) of this Rule.
- (f) A vessel of less than 12 metres in length, when aground, shall not be required to exhibit the lights or shapes prescribed in sub-paragraphs (d)(i) and (ii) of this Rule.

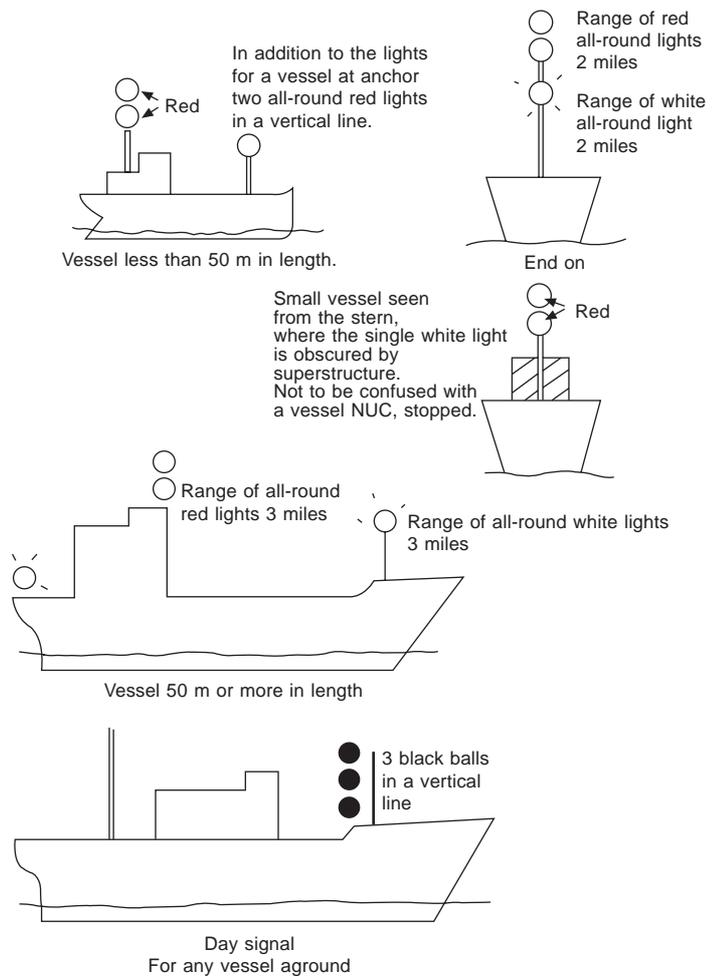


Figure 5.29 Vessel aground.
Sources of reference: Rules 21, 22, 30, and Annex 1.

RULE 31

Seaplanes

Where it is impracticable for a seaplane to exhibit lights and shapes of the characteristics or in the positions prescribed in the Rules of this Part she shall exhibit lights and shapes as closely similar in characteristics and position as is possible.

PART D. SOUND AND LIGHT SIGNALS

RULE 32

Definitions

- (a) The word 'whistle' means any sound signalling appliance capable of producing the prescribed blasts and which complies with the specifications in Annex III to these Regulations.
- (b) The term 'short blast' means a blast of about one second's duration.
- (c) The term 'prolonged blast' means a blast of from four to six seconds' duration.

RULE 33

Equipment for Sound Signals

- (a) A vessel of 12 metres or more in length shall be provided with a whistle and a bell and a vessel of 100 metres or more in length shall, in addition, be provided with a gong, the tone and sound of which cannot be confused with that of the bell. The whistle, bell and gong shall comply with the specifications in Annex III to these Regulations. The bell or gong or both may be replaced by other equipment having the same respective sound characteristics, provided that manual sounding of the prescribed signals shall always be possible.
- (b) A vessel of less than 12 metres in length shall not be obliged to carry the sound signalling appliances prescribed in paragraph (a) of this Rule but if she does not, she shall be provided with some other means of making an efficient sound signal.

RULE 34

Manoeuvring and Warning Signals

- (a) When vessels are in sight of one another, a power-driven vessel underway, when manoeuvring as authorized or required by these Rules, shall indicate that manoeuvre by the following signals on her whistle:
 - one short blast to mean 'I am altering my course to starboard';
 - two short blasts to mean 'I am altering my course to port';
 - three short blasts to mean 'I am operating astern propulsion'.
- (b) Any vessel may supplement the whistle signals prescribed in paragraph (a) of this Rule by light signals, repeated as appropriate, whilst the manoeuvre is being carried out:
 - (i) these light signals shall have the following significance:
 - one flash to mean 'I am altering my course to starboard';
 - two flashes to mean 'I am altering my course to port';
 - three flashes to mean 'I am operating astern propulsion';

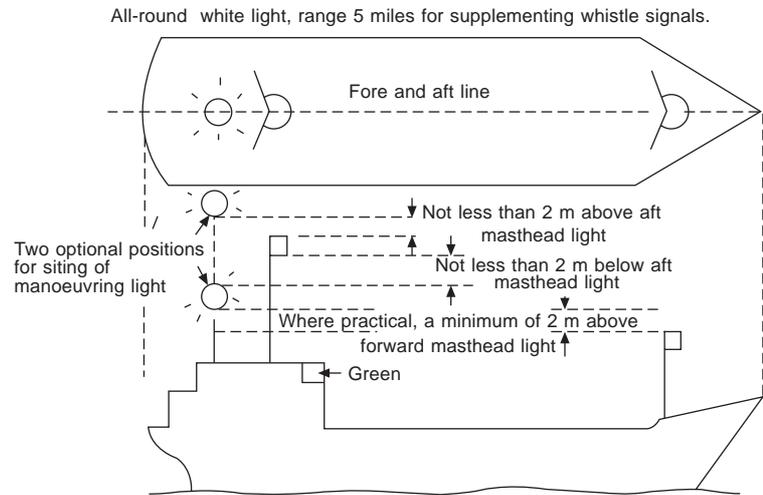


Figure 5.30 Manoeuvring light.
Sources of reference: Rules 34, 36, and Annex 1, Section 12.

This is an optional light, and therefore not necessarily carried by all vessels. When fitted, it should be in the same plane as the masthead lights and conform as near as is practicable to specifications in Annex 1.

- (ii) the duration of each flash shall be about one second, the interval between flashes shall be about one second, and the interval between successive signals shall be not less than ten seconds;
- (iii) the light used for this signal shall, if fitted, be an all-round white light, visible at a minimum range of 5 miles, and shall comply with the provisions of Annex I to these Regulations.
- (c) When in sight of one another in a narrow channel or fairway:
 - (i) a vessel intending to overtake another shall in compliance with Rule 9(e)(i) indicate her intention by the following signals on her whistle:
 - two prolonged blasts followed by one short blast to mean 'I intend to overtake you on your starboard side';
 - two prolonged blasts followed by two short blasts to mean 'I intend to overtake you on your port side';
 - (ii) the vessel about to be overtaken when acting in accordance with Rule 9(e)(i) shall indicate her agreement by the following signal on her whistle:
 - one prolonged, one short, one prolonged and one short blast, in that order.
- (d) When vessels in sight of one another are approaching each other and from any cause either vessel fails to understand the intentions or actions of the other, or is in doubt whether sufficient action is being taken by the other to avoid collision, the vessel in doubt shall immediately indicate such doubt by giving at least five short and rapid blasts on the whistle. Such signal may be supplemented by a light signal of at least five short and rapid flashes.
- (e) A vessel nearing a bend or an area of a channel or fairway where other vessels may be obscured by an intervening obstruction shall sound one prolonged blast. Such signal shall be answered with a prolonged blast by any approaching vessel that may be within hearing around the bend or behind the intervening obstruction.
- (f) If whistles are fitted on a vessel at a distance apart of more than 100 metres, one whistle only shall be used for giving manoeuvring and warning signals.

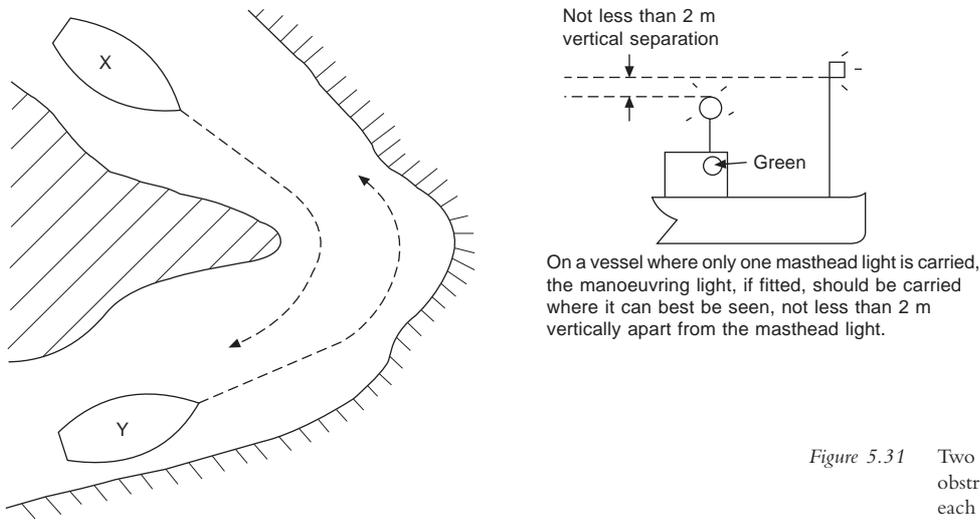


Figure 5.31 Two vessels approaching a bend or an obstruction which obscures the vision of each from the other.

Both vessels 'X' and 'Y' are keeping to their respective starboard sides of the channel, as laid down by Rule 9(a). On approaching a bend or obstruction where the intended path is obscured, a vessel should sound one prolonged blast. Should any other vessel be approaching the same bend or obstruction and be within hearing, she should answer such a signal with a prolonged blast of her own.

Sources of reference: Rules 7, 8, 9, 35 and 36.

RULE 35

Sound Signals in Restricted Visibility

In or near an area of restricted visibility, whether by day or night, the signals prescribed in this Rule shall be used as follows:

- (a) A power-driven vessel making way through the water shall sound at intervals of not more than 2 minutes one prolonged blast.
- (b) A power-driven vessel underway but stopped and making no way through the water shall sound at intervals of not more than 2 minutes two prolonged blasts in succession with an interval of about 2 seconds between them.
- (c) A vessel not under command, a vessel restricted in her ability to manoeuvre, a vessel constrained by her draught, a sailing vessel, a vessel engaged in fishing and a vessel engaged in towing or pushing another vessel shall, instead of the signals prescribed in paragraphs (a) or (b) of this Rule, sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.
- (d) A vessel engaged in fishing, when at anchor, and a vessel restricted in her ability to manoeuvre when carrying out her work at anchor, shall instead of the signals prescribed in paragraph (g) of this Rule sound the signal prescribed in paragraph (c) of this Rule.
- (e) A vessel towed or if more than one vessel is towed the last vessel of the tow, if manned, shall at intervals of not more than 2 minutes sound four blasts in succession, namely one prolonged followed by three short blasts.

When practicable, this signal shall be made immediately after the signal made by the towing vessel.

- (f) When a pushing vessel and a vessel being pushed ahead are rigidly connected in a composite unit they shall be regarded as a power-driven vessel and shall give the signals prescribed in paragraphs (a) or (b) of this Rule.
- (g) A vessel at anchor shall at intervals of not more than one minute ring the bell rapidly for about 5 seconds. In a vessel of 100 metres or more in length the bell shall be sounded in the forepart of the vessel and immediately after the ringing of the bell the gong shall be sounded rapidly for about 5 seconds in the after part of the vessel. A vessel at anchor may in addition sound three blasts in succession, namely one short, one prolonged and one short blast, to give warning of her position and of the possibility of collision to an approaching vessel.
- (h) A vessel aground shall give the bell signal and if required the gong signal prescribed in paragraph (g) of this Rule and shall, in addition, give three separate and distinct strokes on the bell immediately before and after the rapid ringing of the bell. A vessel aground may in addition sound an appropriate whistle signal.
- (i) A vessel of less than 12 metres in length shall not be obliged to give the above-mentioned signals but, if she does not, shall make some other efficient sound signal at intervals of not more than 2 minutes.
- (j) A pilot vessel when engaged on pilotage duty may in addition to the signals prescribed in paragraphs (a), (b) or (g) of this Rule sound an identity signal consisting of four short blasts.

RULE 36

Signals to Attract Attention

If necessary to attract the attention of another vessel any vessel may make light or sound signals, that cannot be mistaken for any signal authorized elsewhere in these Rules, or may direct the beam of her searchlight in the direction of the danger, in such a way as not to embarrass any vessel. Any light to attract the attention of another vessel shall be such that it cannot be mistaken for any aid to navigation. For the purpose of this Rule the use of high intermittent or revolving lights, such as strobe lights, shall be avoided.

RULE 37

Distress Signals

When a vessel is in distress and requires assistance she shall use or exhibit the signals described in Annex IV to these Regulations.

PART E. EXEMPTIONS

RULE 38

Exemptions

Any vessel (or class of vessels) provided that she complies with the requirements of the International Regulations for Preventing Collisions at Sea, 1960(a), the keel of which is laid or which is at a corresponding stage of construction before the entry into force of these Regulations may be exempted from compliance therewith as follows:

- (a) The installation of lights with ranges prescribed in Rule 22, until four years after the date of entry into force of these Regulations.
- (b) The installation of lights with colour specifications as prescribed in Section 7 of Annex I to these Regulations, until four years after the date of entry into force of these Regulations.
- (c) The repositioning of lights as a result of conversion from Imperial to metric units and rounding off measurement figures, permanent exemption.
- (d)
 - (i) The repositioning of masthead lights on vessels of less than 150 metres in length, resulting from the prescriptions of Section 3(a) of Annex I to these Regulations, permanent exemption.
 - (ii) The repositioning of masthead lights on vessels of 150 metres or more in length, resulting from the prescriptions of Section 3(a) of Annex I to these Regulations, until nine years after the date of entry into force of these Regulations.
- (e) The repositioning of masthead lights resulting from the prescriptions of Section 2(b) of Annex I to these Regulations, until nine years after the date of entry into force of these Regulations.
- (f) The repositioning of sidelights resulting from the prescriptions of Sections 2(g) and 3(b) of Annex I to these Regulations, until nine years after the date of entry into force of these Regulations.
- (g) The requirements for sound signal appliances prescribed in Annex III to these Regulations, until nine years after the date of entry into force of these Regulations.
- (h) The repositioning of all-round lights resulting from the prescription of Section 9(b) of Annex I to these Regulations, permanent exemption.

ANNEX I

Positioning and technical details of lights and shapes

1. Definition

The term 'height above the hull' means height above the uppermost continuous deck. This height shall be measured from the position vertically beneath the location of the light.

2. Vertical positioning and spacing of lights

- (a) On a power-driven vessel of 20 metres or more in length the masthead lights shall be placed as follows:
 - (i) the forward masthead light, or if only one masthead light is carried, then that light, at a height above the hull of not less than 6 metres, and, if the breadth of the vessel exceeds 6 metres, then at a height above the hull not less than such breadth, so however that the light need not be placed at a greater height above the hull than 12 metres;
 - (ii) when two masthead lights are carried the after one shall be at least 4.5 metres vertically higher than the forward one.
- (b) The vertical separation of masthead lights of power-driven vessels shall be such that in all normal conditions of trim the after light will be seen over and separate from the forward light at a distance of 1,000 metres from the stem when viewed from sea level.
- (c) The masthead light of a power-driven vessel of 12 metres but less than 20 metres in length shall be placed at a height above the gunwale of not less than 2.5 metres.

- (d) A power-driven vessel of less than 12 metres in length may carry the uppermost light at a height of less than 2.5 metres above the gunwale. When however a masthead light is carried in addition to sidelights and a sternlight, then such masthead light shall be carried at least 1 metre higher than the sidelights.
- (e) One of the two or three masthead lights prescribed for a power-driven vessel when engaged in towing or pushing another vessel shall be placed in the same position as either the forward masthead light or the after masthead light: provided that, if carried on the aftermast, the lowest after masthead light shall be at least 4.5 metres vertically higher than the forward masthead light.
- (f)
 - (i) The masthead light or lights prescribed in Rule 23(a) shall be so placed as to be above and clear of all other lights and obstructions except as described in sub-paragraph (ii).
 - (ii) When it is impracticable to carry the all-round lights prescribed by Rule 27(b)(i) or Rule 28 below the masthead lights, they may be carried above the after masthead light(s) or vertically in between the forward masthead light(s) and after masthead light(s), provided that in the latter case the requirement of Section 3(c) of this Annex shall be complied with.
- (g) The sidelights of a power-driven vessel shall be placed at a height above the hull not greater than three-quarters of that of the forward masthead light. They shall not be so low as to be interfered with by deck lights.
- (h) The sidelights, if in a combined lantern and carried on a power-driven vessel of less than 20 metres in length, shall be placed not less than 1 metre below the masthead light.
- (i) When the Rules prescribe two or three lights to be carried in a vertical line, they shall be spaced as follows:
 - (i) on a vessel of 20 metres in length or more such lights shall be spaced not less than 2 metres apart, and the lowest of these lights shall, except where a towing light is required, be placed at a height of not less than 4 metres above the hull;
 - (ii) on a vessel of less than 20 metres in length such lights shall be spaced not less than 1 metre apart and the lowest of these lights shall, except where a towing light is required, be placed at a height of not less than 2 metres above the hull;
 - (iii) when three lights are carried they shall be equally spaced.
- (j) The lower of the two all-round lights prescribed for a vessel when engaged in fishing shall be at a height above the sidelights not less than twice the distance between the two vertical lights.
- (k) The forward anchor light prescribed in Rule 30(a)(i), when two are carried, shall not be less than 4.5 metres above the after one. On a vessel of 50 metres or more in length this forward anchor light shall be placed at a height of not less than 6 metres above the hull.

3. *Horizontal positioning and spacing of lights*

- (a) When two masthead lights are prescribed for a power-driven vessel, the horizontal distance between them shall not be less than one-half of the length of vessel but need not be more than 100 metres. The forward light shall be placed not more than one-quarter of the length of the vessel from the stem.
- (b) On a power-driven vessel of 20 metres or more in length the sidelights shall not be placed in front of the forward masthead lights. They shall be placed at or near the side of the vessel.

- (c) When the lights prescribed in Rule 27(b)(i) or Rule 28 are placed vertically between the forward masthead light(s) and the after masthead light(s) these all-round lights shall be placed at a horizontal distance of not less than 2 metres from the fore and aft centreline of the vessel in the athwartship direction.
4. *Details of location of direction-indicating lights for fishing vessels, dredgers and vessels engaged in underwater operations*
- (a) The light indicating the direction of the outlying gear from a vessel engaged in fishing as prescribed in Rule 26(e)(ii) shall be placed at a horizontal distance of not less than 2 metres and not more than 6 metres away from the two all-round red and white lights. This light shall be placed not higher than the all-round white light prescribed in Rule 26(c)(i) and not lower than the sidelights.
- (b) The lights and shapes on a vessel engaged in dredging or underwater operations to indicate the obstructed side and/or the side on which it is safe to pass, as prescribed in Rule 27(d)(i) and (ii), shall be placed at the maximum practical horizontal distance, but in no case less than 2 metres, from the lights or shapes prescribed in Rule 27(b)(i) and (ii). In no case shall the upper of these lights or shapes be at a greater height than the lower of the three lights or shapes prescribed in Rule 27(b)(i) and (ii).
5. *Screens for sidelights*
- The sidelights of vessels of 20 metres or more in length shall be fitted with inboard screens painted matt black, and meeting the requirements of Section 9 of this Annex. On vessels of less than 20 metres in length the sidelights, if necessary to meet the requirements of Section 9 of this Annex, shall be fitted with inboard matt black screens. With a combined lantern, using a single vertical filament and a very narrow division between the green and red sections, external screens need not be fitted.

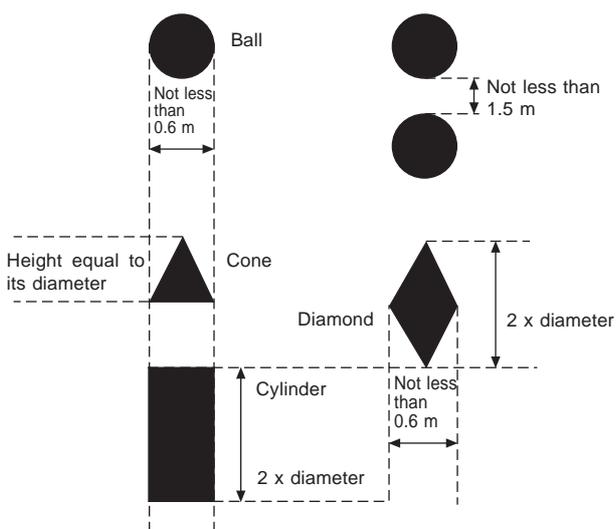


Figure 5.32 Shape specifications for vessel of 20 m or more in length. All shapes are black.

In a vessel less than 20 m in length the shapes' dimensions may be less than those given, but must be commensurate with the size of the vessel. Distance between shapes may also be correspondingly reduced.

6. *Shapes*

Shapes shall be black and of the following sizes:

- (a) (i) a ball shall have a diameter of not less than 0.6 metre;
- (ii) a cone shall have a base diameter of not less than 0.6 metre and a height equal to its diameter;
- (iii) a cylinder shall have a diameter of at least 0.6 metre and a height of twice its diameter;
- (iv) a diamond shape shall consist of two cones as defined in (ii) above having a common base.
- (b) The vertical distance between shapes shall be at least 1.5 metres.
- (c) In a vessel of less than 20 metres in length shapes of lesser dimensions but commensurate with the size of the vessel may be used and the distance apart may be correspondingly reduced.

7. *Colour specification of lights*

The chromaticity of all navigation lights shall conform to the following standards, which lie within the boundaries of the area of the diagram specified for each colour by the International Commission on Illumination (CIE).

The boundaries of the area for each colour are given by indicating the corner co-ordinates, which are as follows:

(i) <i>White</i>						
x	0.525	0.525	0.452	0.310	0.310	0.443
y	0.382	0.440	0.440	0.348	0.283	0.382
(ii) <i>Green</i>						
x	0.028	0.009	0.300	0.203		
y	0.385	0.723	0.511	0.356		
(iii) <i>Red</i>						
x	0.680	0.660	0.735	0.721		
y	0.320	0.320	0.265	0.259		
(iv) <i>Yellow</i>						
x	0.612	0.618	0.575	0.575		
y	0.382	0.382	0.425	0.406		

8. *Intensity of lights*

- (a) The minimum luminous intensity of lights shall be calculated by using the formula:

$$I = 3.43 \times 10^6 \times T \times D^2 \times K^{-D}$$

where I is luminous intensity in candelas under service conditions,

T is threshold factor 2×10^{-7} lux,

D is range of visibility (luminous range) of the light in nautical miles,

K is atmospheric transmissivity.

For prescribed lights the value of K shall be 0.8, corresponding to a meteorological visibility of approximately 13 nautical miles.

- (b) A selection of figures derived from the formula is given in the following table:

<i>Range of visibility (luminous range) of light in nautical miles D</i>	<i>Luminous intensity of light in candelas for K = 0.8 I</i>
1	0.9
2	4.3
3	12
4	27
5	52
6	94

Note: The maximum luminous intensity of navigation lights should be limited to avoid undue glare. This shall not be achieved by a variable control of the luminous intensity.

9. *Horizontal sectors*

- (a) (i) In the forward direction, sidelights as fitted on the vessel shall show the minimum required intensities. The intensities shall decrease to reach practical cut-off between 1 degree and 3 degrees outside the prescribed sectors.
- (ii) For sternlights and masthead lights and at 22.5 degrees abaft the beam for sidelights, the minimum required intensities shall be maintained over the arc of the horizon up to 5 degrees within the limits of the sectors prescribed in Rule 21. From 5 degrees within the prescribed sectors the intensity may decrease by 50 per cent up to the prescribed limits; it shall decrease steadily to reach practical cut-off at not more than 5 degrees outside the prescribed sectors.
- (b) (i) All-round lights shall be so located as not to be obscured by masts, topmasts or structures within angular sectors of more than 6 degrees except anchor lights prescribed in Rule 30, which need not be placed at an impracticable height above the hull.
- (ii) If it is impracticable to comply with paragraph (b)(i) of this section by exhibiting only one all-round light, two all-round lights shall be used suitably positioned or screened so that they appear, as far as practicable, as one light at a distance of one mile.

10. *Vertical sectors*

- (a) The vertical sectors of electric lights as fitted, with the exception of lights on sailing vessels shall ensure that:
- (i) at least the required minimum intensity is maintained at all angles from 5 degrees above to 5 degrees below the horizontal;
- (ii) at least 60 per cent of the required minimum intensity is maintained from 7.5 degrees above to 7.5 degrees below the horizontal.
- (b) In the case of sailing vessels the vertical sectors of electric lights as fitted shall ensure that:
- (i) at least the required minimum intensity is maintained at all angles from 5 degrees above to 5 degrees below the horizontal;
- (ii) at least 50 per cent of the required minimum intensity is maintained from 25 degrees above to 25 degrees below the horizontal.
- (c) In the case of lights other than electric these specifications shall be met as closely as possible.

11. *Intensity of non-electric lights*

Non-electric lights shall so far as practicable comply with the minimum intensities, as specified in the table given in Section 8 of this Annex.

12. *Manoeuvring light*

Notwithstanding the provisions of paragraph 2(f) of this Annex the manoeuvring light described in Rule 34(b) shall be placed in the same fore and aft vertical plane as the masthead light or lights and, where practicable, at a minimum height of 2 metres vertically above the forward masthead light, provided that it shall be carried not less than 2 metres vertically above or below the after masthead light. On a vessel where only one masthead light is carried the manoeuvring light, if fitted, shall be carried where it can best be seen, not less than 2 metres vertically apart from the masthead light.

13. *High Speed Craft*

The masthead light of high speed craft with a length to breadth ratio of less than 3.0 may be placed at a height related to the breadth of the craft lower than that prescribed in paragraph 2(a)(i) of this Annex, provided that the base angle of the isosceles triangles formed by the sidelights and masthead light, when seen in end elevation, is not less than 27 degrees.

14. *Approval*

The construction of lights and shapes and the installation of lights on board the vessel shall be to the satisfaction of the appropriate authority of the State.

ANNEX II

Additional signals for fishing vessels fishing in close proximity1. *General*

The lights mentioned herein shall, if exhibited in pursuance of Rule 26(d), be placed where they can best be seen. They shall be at least 0.9 metre apart but at a lower level than lights prescribed in Rule 26(b)(i) and (c)(i). The lights shall be visible all round the horizon at a distance of at least 1 mile but at a lesser distance than the lights prescribed by these Rules for fishing vessels.

2. *Signals for trawlers*

(a) Vessels when engaged in trawling, whether using demersal or pelagic gear, may exhibit:

- (i) when shooting their nets:
 - two white lights in a vertical line;
- (ii) when hauling their nets:
 - one white light over one red light in a vertical line;
- (iii) when the net has come fast upon an obstruction:
 - two red lights in a vertical line.

(b) Each vessel engaged in pair trawling may exhibit:

- (i) by night, a searchlight directed forward and in the direction of the other vessel of the pair.
- (ii) when shooting or hauling their nets or when their nets have come fast upon an obstruction, the lights prescribed in 2(a) above.

(c) A vessel of less than 20 metres in length engaged in trawling, whether using demersal or pelagic gear or engaged in pair trawling, may exhibit the lights prescribed in paragraphs (a) or (b) of this Section, as appropriate.

3. *Signals for purse seiners*

Vessels engaged in fishing with purse seine gear may exhibit two yellow lights in a vertical line. These lights shall flash alternately every second and with

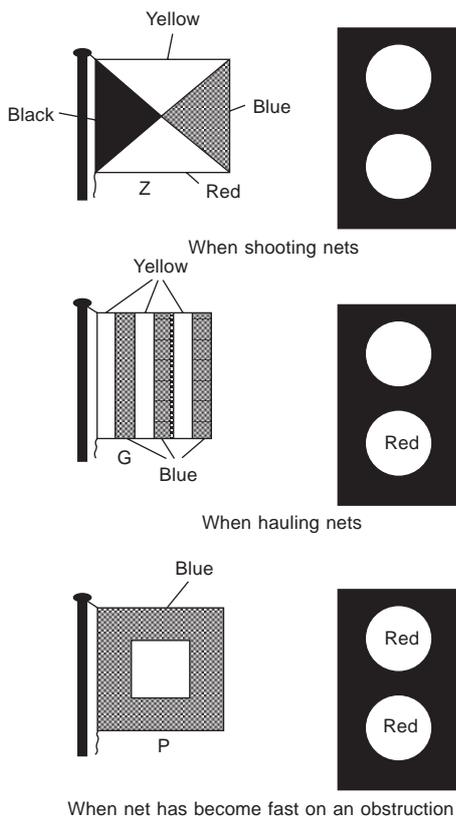


Figure 5.33 Additional signals for vessels fishing.

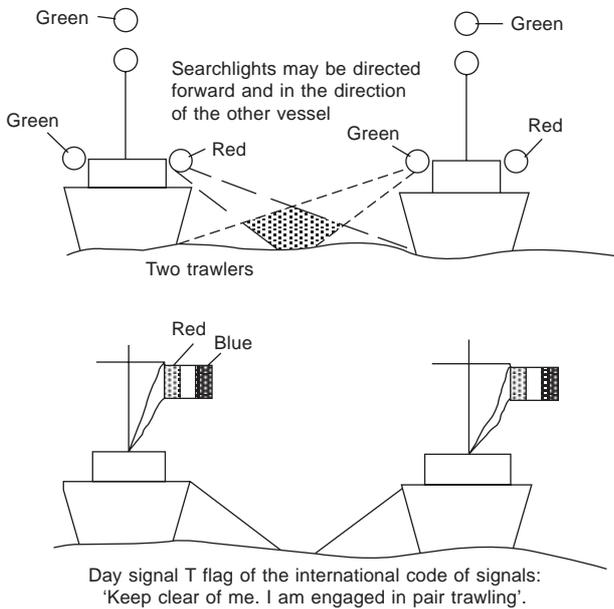


Figure 5.34 Fishing vessels engaged in pair trawling. Sources of reference: Rules 3, 9(c), 10, 18, 26, 36, Annex 1.

equal light and occultation duration. These lights may be exhibited only when the vessel is hampered by its fishing gear.

ANNEX III

Technical details of sound signal appliances

1. Whistles

(a) Frequencies and range of audibility

The fundamental frequency of the signal shall lie within the range 70–700 Hz.

The range of audibility of the signal from a whistle shall be determined by those frequencies, which may include the fundamental and/or one or more higher frequencies, which lie within the range 180–700 Hz (± 1 per cent) and which provide the sound pressure levels specified in paragraph 1(c) below.

(b) Limits of fundamental frequencies

To ensure a wide variety of whistle characteristics, the fundamental frequency of a whistle shall be between the following limits:

- (i) 70–200 Hz, for a vessel 200 metres or more in length;
- (ii) 130–350 Hz, for a vessel 75 metres but less than 200 metres in length;
- (iii) 250–700 Hz, for a vessel less than 75 metres in length.

(c) Sound signal intensity and range of audibility

A whistle fitted in a vessel shall provide, in the direction of maximum intensity of the whistle and at a distance of 1 metre from it, a sound pressure level in at least one 1/3rd-octave band within the range of frequencies 180–700 Hz ± 1 per cent of not less than the appropriate figure given in the table below.

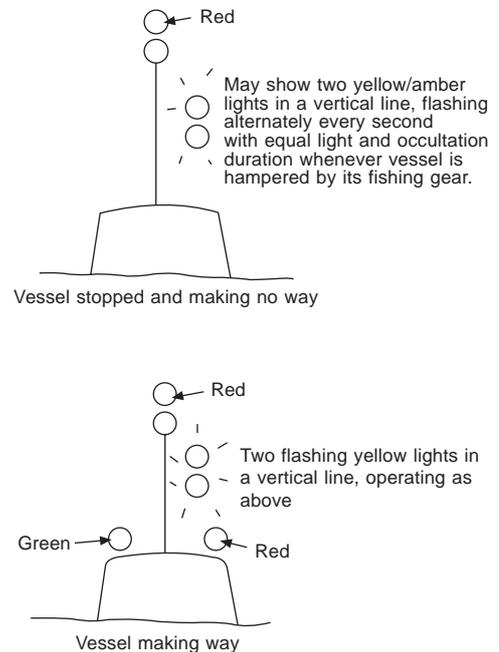


Figure 5.35 Special signals for purse seiners. Sources of reference: Annex II and M 587, July 1970.

<i>Length of vessel in metres</i>	<i>1/3rd-octave band level at 1 metre in dB referred to 2×10^{-5} N/m²</i>	<i>Audibility range in nautical miles</i>
200 or more	143	2
75 but less than 200	138	1.5
20 but less than 75	130	1
Less than 20	120	0.5

The range of audibility in the table above is for information and is approximately the range at which a whistle may be heard on its forward axis with 90 per cent probability in conditions of still air on board a vessel having average background noise level at the listening posts (taken to be 68 dB in the octave band centred on 250 Hz and 63 dB in the octave band centred on 500 Hz).

In practice the range at which a whistle may be heard is extremely variable and depends critically on weather conditions; the values given can be regarded as typical but under conditions of strong wind or high ambient noise level at the listening post the range may be much reduced.

(d) *Direction properties*

The sound pressure level of a directional whistle shall be not more than 4 dB below the prescribed sound pressure level on the axis at any direction in the horizontal plane within ± 45 degrees of the axis. The sound pressure level at any other direction in the horizontal plane shall be not more than 10 dB below the prescribed sound pressure level on the axis, so that the range in any direction will be at least half the range on the forward axis. The sound pressure level shall be measured in that 1/3rd-octave band which determines the audibility range.

(e) *Positioning of whistles*

When a directional whistle is to be used as the only whistle on a vessel, it shall be installed with its maximum intensity directed straight ahead.

A whistle shall be placed as high as practicable on a vessel, in order to reduce interception of the emitted sound by obstructions and also to minimize hearing damage risk to personnel. The sound pressure level of the vessel's own signal at listening posts shall not exceed 110 dB (A) and so far as practicable should not exceed 100 dB (A).

(f) *Fitting of more than one whistle*

If whistles are fitted at a distance apart of more than 100 metres, it shall be so arranged that they are not sounded simultaneously.

(g) *Combined whistle systems*

If due to the presence of obstructions the sound field of a single whistle or of one of the whistles referred to in paragraph 1(f) above is likely to have zone of greatly reduced signal level, it is recommended that a combined whistle system be fitted so as to overcome this reduction. For the purposes of the Rules a combined whistle system is to be regarded as a single whistle. The whistles of a combined system shall be located at a distance apart of not more than 100 metres and arranged to be sounded simultaneously. The frequency of any one whistle shall differ from those of the others by at least 10 Hz.

2. *Bell or gong*
 - (a) *Intensity of signal*
A bell or gong, or other device having similar sound characteristics shall produce a sound pressure level of not less than 100 dB at a distance of 1 metre from it.
 - (b) *Construction*
Bells and gongs shall be made of corrosion-resistant material and designed to give a clear tone. The diameter of the mouth of the bell shall be not less than 300 mm for vessels of 20 metres or more in length, and shall be not less than 200 mm for vessels of 12 metres or more but of less than 20 metres in length.
Where practicable, a power-driven bell striker is recommended to ensure constant force but manual operation shall be possible. The mass of the striker shall be not less than 3 per cent of the mass of the bell.
3. *Approval*
The construction of sound signal appliances, their performance and their installation on board the vessel shall be to the satisfaction of the appropriate authority of the State whose flag the vessel is entitled to fly.

ANNEX IV

Distress signals

1. The following signals, used or exhibited either together or separately, indicate distress and need of assistance:
 - (a) a gun or other explosive signal fired at intervals of about a minute;
 - (b) a continuous sounding with any fog-signalling apparatus;
 - (c) rockets or shells, throwing red stars fired one at a time at short intervals;
 - (d) a signal made by radiotelegraphy or by any other signalling method consisting of the group · · · — — — · · · (SOS) in the Morse Code;
 - (e) a signal sent by radiotelephony consisting of the spoken word 'Mayday';
 - (f) the International Code Signal of distress indicated by N.C.;
 - (g) a signal consisting of a square flag having above or below it a ball or anything resembling a ball;
 - (h) flames on the vessel (as from a burning tar barrel, oil barrel, etc.);
 - (i) a rocket parachute flare or a hand flare showing a red light;
 - (j) a smoke signal giving off orange-coloured smoke;
 - (k) slowly and repeatedly raising and lowering arms outstretched to each side;
 - (l) the radiotelegraph alarm signal;
 - (m) the radiotelephone alarm signal;
 - (n) signals transmitted by emergency position-indicating radio beacons;
 - (o) approved signals transmitted by radiocommunication systems, including survival craft radar responders.
2. The use of exhibition of any of the foregoing signals except for the purpose of indicating distress and need of assistance and the use of other signals which may be confused with any of the above signals is prohibited.
3. Attention is drawn to the relevant sections of the International Code of Signals the Merchant Ship Search and Rescue Manual and the following signals:
 - (a) a piece of orange-coloured canvas with either a black square and circle or other appropriate symbol (for identification from the air);
 - (b) a dye marker.

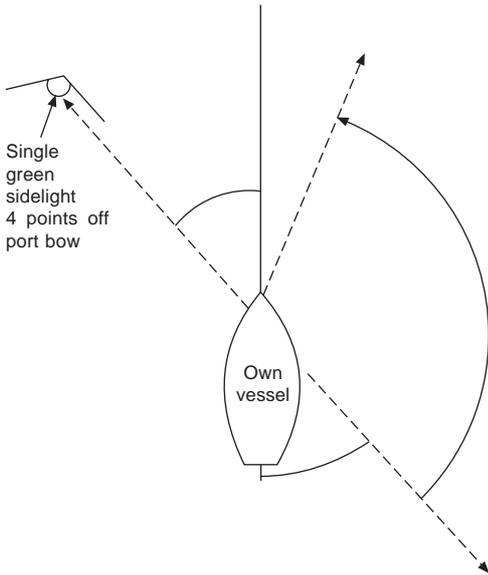


Figure 5.36 Judging heading from another vessel's green light.

First stage. Reverse the bearing of the observed light and you will get a line 4 points off the starboard quarter. This line gives one limit to the direction in which the other vessel is heading.

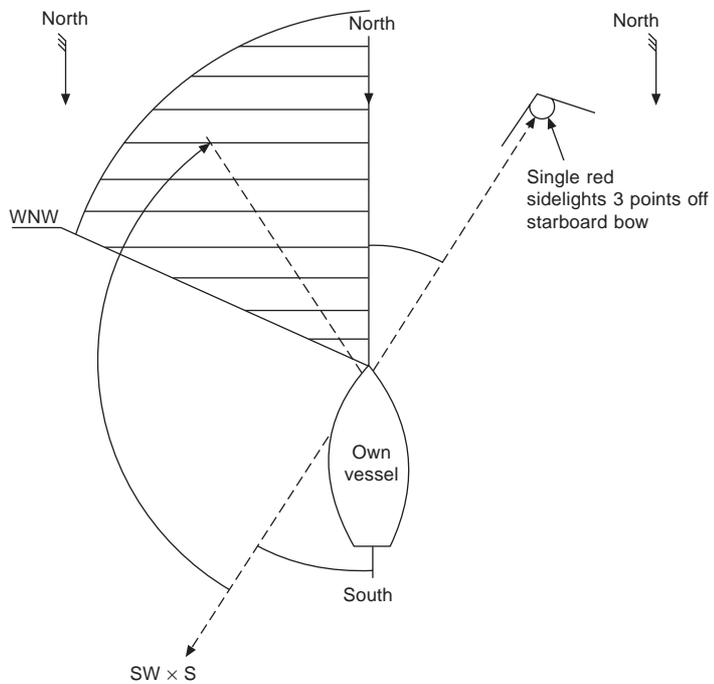
Second stage. From the reversed bearing traverse 10 points to the left, which gives 2 points off the starboard bow. This is the second and final limit to the direction in which the other vessel is heading, as defined by the arc of visibility of the sidelight.

Figure 5.37 Judging heading of sailing vessel from red light.

First stage. Reverse the bearing of the observed light and you will get a line 3 points off the port quarter. This line gives one limit to the direction in which the other ship is heading.

Second stage. From the reversed bearing traverse 10 points to the right, which gives 3 points off the port bow. This is the second limit to the direction in which the other vessel is heading, as defined by the arc of visibility of the sidelight.

Third stage. Assuming that the other vessel will not be able to sail closer to the wind than 6 points of the compass a 'no go' area may be established 6 points either side of the wind direction. If the wind is blowing from the north, say, the other vessel is sailing between SW by S and WNW.



JUDGING ANOTHER VESSEL'S HEADING AT NIGHT

We know that the arc of a sidelight shows over $112\frac{1}{2}^\circ$ 10 points of the compass. Therefore we can assume that to an observer of a sidelight the direction of an observed ship's head must be related to the limits of that arc, otherwise the observer would see either the opposing sidelight or the stern light. Refer now to Figure 5.36.

The observer has narrowed the other vessel's heading from 4 points off the starboard quarter to 2 points off the starboard bow. By relating these limits to your own vessel's course, you may define the heading of the other vessel by points of the compass. If it is assumed in Figure 5.36, for example, that your own vessel's course is north, then the other vessel is heading between SE and NNE.

The direction in which a sailing vessel is proceeding will depend on the wind direction. Let us assume your own vessel is moving north and a single red light is seen at 3 points off the starboard bow. Let us assume it is a sailing vessel, and consider her heading and direction of sailing. Refer to Figure 5.37.

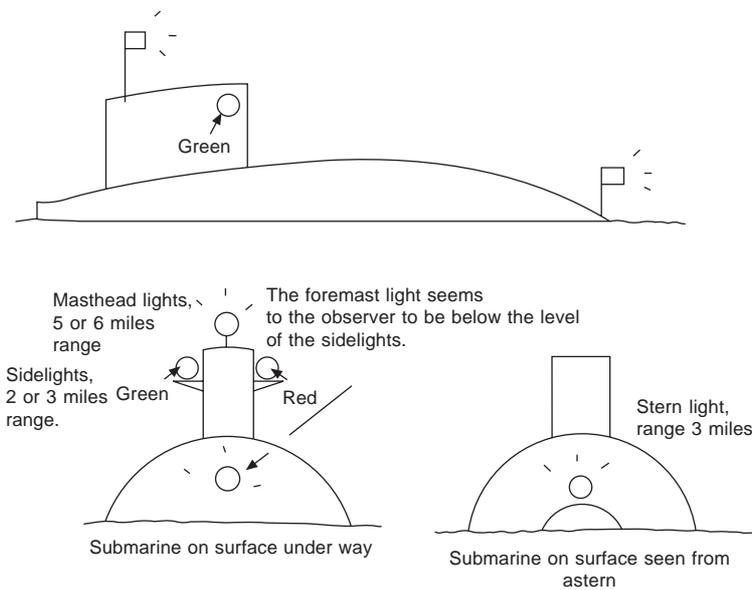
SPECIAL CASES TO RULE OF THE ROAD

Warships

Warships cannot always comply with the regulations concerning the disposition of navigation lights. Bearing this in mind, navigators should take extreme caution when navigation in their vicinity.

The aspect of an approaching warship may often be deceiving, especially when the separation between lights cannot be met by the very nature of the construction of the vessel. This separation between lights may lead to the misconception that there are two ships when in fact there is only one. Submarines also, when operating on or near the surface, may have the stern light, which is carried close to the surface, obscured by wash or spray (see Figure 5.38).

Some warships of over 50 m in length, because of their construction, cannot be fitted with the second masthead light. This applies especially to certain frigates, minesweepers and boom defence vessels.



Watchkeepers should set additional lookouts when navigating in submarine exercise areas or in the vicinity of ports servicing and accommodating submarines. Other warships often operate in conjunction with submarines and a wide berth is advised, if circumstances permit. Submarines at anchor exhibit normal anchor lights as for vessels of their length, but in addition will exhibit, midships, an all-round white light.

Some submarines are fitted with a quick-flashing amber light for the purpose of identification in narrow channels and in dense traffic areas. This light, normally fitted above the after steaming light, flashes at a rate of 90 or more per minute.

Figure 5.38 Submarine lights.

Aircraft carriers, although they generally have their sidelights positioned either side of the flight deck, sometimes have sidelights on either side of the island structure. Their red, white, red, all-round lights should only be exhibited when they are engaged in the launching or recovery of aircraft fixed wing or rotary wing (see Figure 5.39).

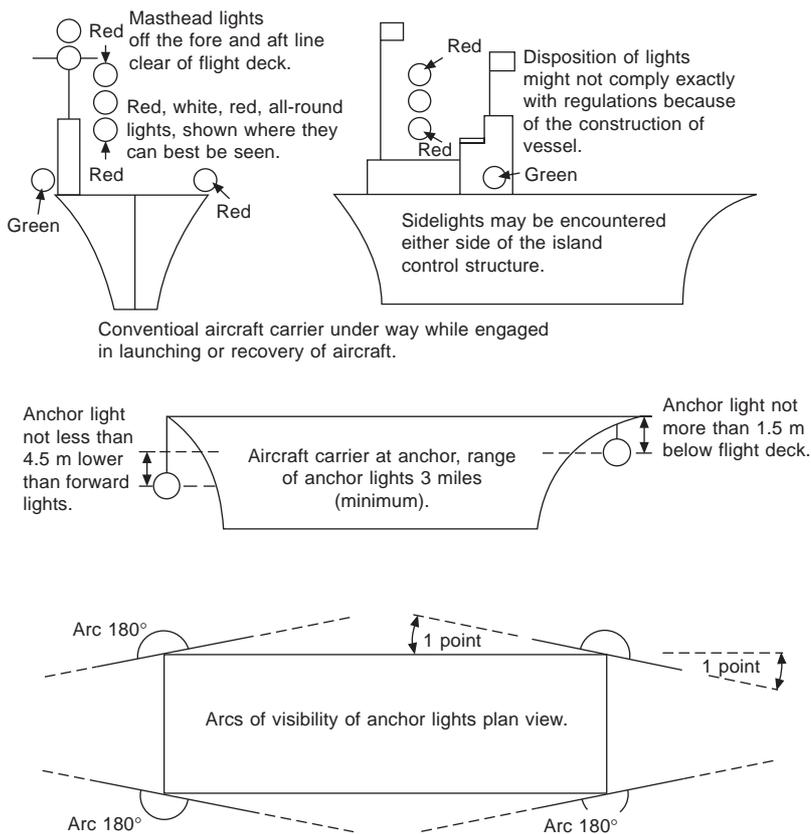


Figure 5.39 Aircraft carrier lights.

Hovercraft (air-cushion vessel)

The speed of hovercraft may be as much as 80 knots, but they can stop extremely quickly if the need arises. Their construction makes them susceptible to wind effects. This, together with the fact that their navigation lights (Figure 5.40) may be placed unconventionally, could give an observer a false indication of their position. The flashing amber light should not be confused with the similar light shown by some submarines. Frequency of the flashing light for hovercraft should comply with Rule 21f and operate at 120 flashes or more per minute.

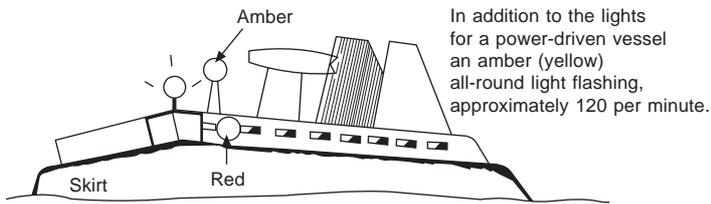


Figure 5.40 Hovercraft lights.

Considerable noise accompanies the movement of hovercraft and this may disguise the sound signals. In addition, it will be unlikely that any sound signals given by other vessels will be heard by persons aboard the hovercraft.

Oil Rig/Production Platform

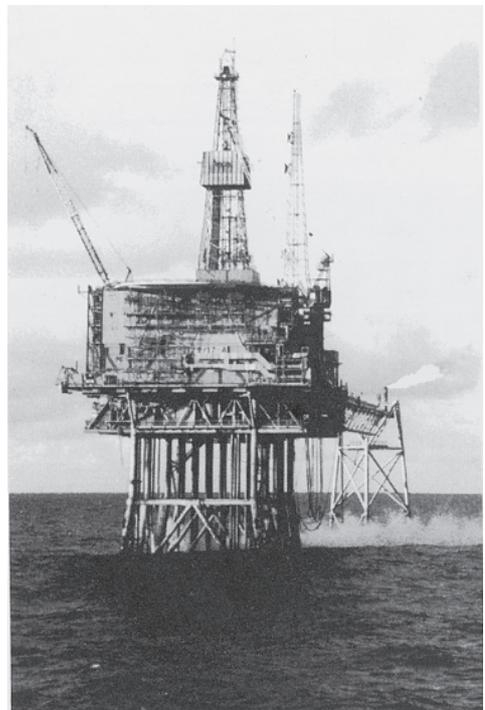
The difference between a rig and a production platform is that a rig is of a temporary nature and moves from position to position, and a production platform is of a fixed nature and permanently attached to the sea bed. The safety zones for oil rigs and production platforms may vary from country to country, and in the absence of relevant information they must be assumed to exist.

Usually rigs and production platforms make extensive use of all available deck lighting, as an additional aid to navigation as well as working illumination (see Figure 5.41).

For safety and profitability production platforms need to fulfil the following conditions (By the very nature of their occupation and changing technology this criterion must be accepted as being variable):

1. Height from sea bed to top of drilling derrick 690 ft (210 m).
2. Height of top deck from sea bed 550 ft (167.6 m)
3. Drilling radius covered from platform 9000 ft (2743 m).
4. Directional drilling, maximum deviation, 55°.
5. Nominal production per day – 125,000 barrels (variable).
6. Total number of piles – 44.
7. Number of piles in each leg – 11.
8. Maximum depth of piles 250 ft (76.2 m).
9. Diameter of main flotation legs 30 ft (9.1 m).
10. Clearance of lowest deck from mean sea level 77 ft (23.5 m).
11. Number of deck levels – 3.
12. Deck dimensions 175 ft (53.3 m) × 170 ft (51.8 m).

Accommodation on each platform will vary, but 200 men at any one time is not uncommon. Lifesaving appliances generally include either Survival Systems International capsules or totally enclosed lifeboats together with life rafts.



19. Operational offshore installation.

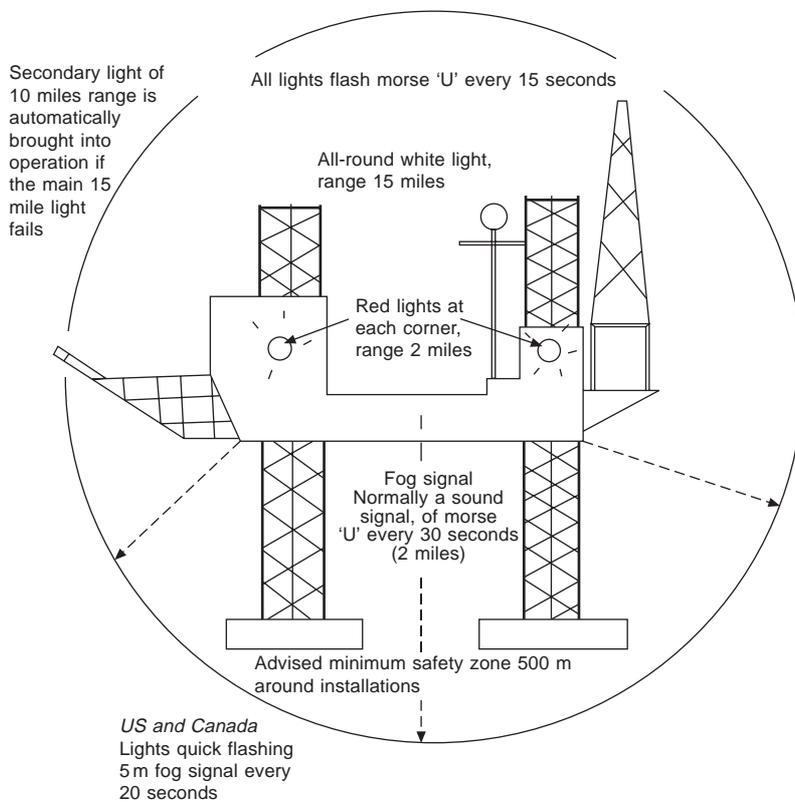


Figure 5.41 Lights on oil rigs and production platforms.

Seaplane

The word 'seaplane' includes any aircraft designed to manoeuvre on the water. Non-displacement craft and seaplanes should be considered as vessels, but non-displacement craft are not to be considered as seaplanes.

This seaplane on the water will exhibit the lights as for a power-driven vessel of her length. By the very nature of her construction the difference in height between white masthead lights and sidelights will be minimal, and may even appear in one horizontal line (see Figure 5.42).

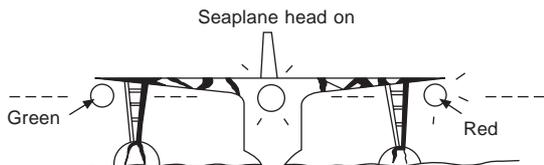


Figure 5.42 Seaplane lights.

Remote-controlled Craft

These craft, normally 19.2 m in length, exhibit the usual navigation lights and shapes, together with 'not under command' signals. They are usually engaged with a controlling craft, which operates in or near the area and keeps a visual and radar watch for up to about 8 miles. Additional air cover is provided to cover greater ranges and ensure shipping safety.

Warning red fixed or red flashing lights may be exhibited at night, or red flags by day, to indicate target practice by aircraft, shore battery, or ships at sea. Targets may be illuminated at night by bright red or orange flares. Mariners should be aware that the absence of such signals does not mean that a practice area does not exist. See Figure 5.43.

Additional information is given in the *Mariners Handbook* and *Annual Summary of Notices to Mariners*.

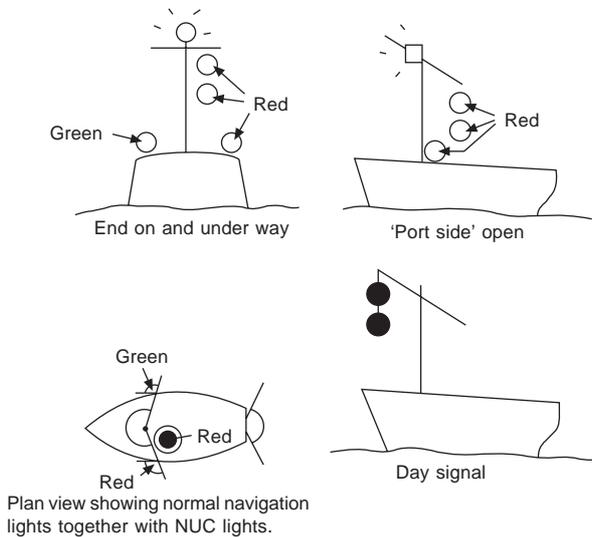


Figure 5.43 Lights and shape designating remote-controlled craft.

RULE OF THE ROAD – QUESTIONS AND SUGGESTED ANSWERS FOR WATCHKEEPING OFFICERS

1. What action would you take as a watchkeeping officer when your vessel is observed to be approaching a fog bank right ahead?

Main engines would be placed on immediate 'stand by', and the vessel's speed reduced to what must be considered safe. Lookouts would be placed and radar made fully operational, with systematic plotting on targets in vicinity. Fog signals would be sounded before entering the fog bank, and, the Master of the vessel informed of reduced visibility. If possible, the vessel's position would be ascertained before she entered the fog bank.

2. When a sailing vessel encounters a vessel not under command, which vessel is deemed to be the give way vessel, under normal circumstances?

The sailing vessel would normally give way to the NUC vessel (Rule 18(b)). Unless the NUC vessel is overtaking.

3. When would a power-driven vessel under way, change her fog signal from one prolonged blast to two prolonged blasts at intervals of not more than two minutes?
When the vessel has stopped and is making no way through the water (Rule 35(b)).
4. What is the fog signal for a vessel engaged in underwater operations when at anchor?
One prolonged blast followed by two short blasts at intervals of not more than two minutes (Rule 35(c)).
5. What are the stated limits of the danger area about a mine clearance vessel when engaged in minesweeping operations?
Minimum of 1000 m radius about the vessel (Rule 27(f)).
6. In ascertaining whether risk of collision exists, why are compass bearings advised rather than other methods of checking the bearing of a target?
By use of compass bearings as opposed to relative bearings the 'yaw' of the ship's head is eliminated. If radar bearings are taken instead of compass bearings, then the instrument is assumed to be functioning at 100 per cent efficiency, which is not always the case (Rule 7(d)(i)).
7. How would you check that your radar equipment is functioning in a correct manner?
Operate the performance monitor to obtain the plume or biscuit, as per radar specifications.
8. A vessel at anchor observes another vessel on a collision course towards her. Can the vessel at anchor sound the signal, 'one short blast, one prolonged blast, followed by one short blast', as stated in Rule 35(f)?
No. Rule 35 applies to vessels in restricted visibility. In this case both vessels are in sight of one another. If any signal was to be given, it should be 'at least five short and rapid blasts' as per (Rule 34(d)).
9. What day signal is displayed by a vessel aground?
Three 'black balls in a vertical line' shown where they can best be seen (Rule 30(d)(ii)).
10. What would a sailing vessel display by day when under sail and under power?
A 'black cone', apex down, where it can best be seen (Rule 25(e)).
11. What lights would be shown by a vessel under sail and under power between sunset and sunrise?
She would exhibit the normal lights for a power-driven vessel of her length (Rule 3(b)).
12. What is the arc of visibility of the stern light, in degrees?
135° (Rule 21(c)).
13. Which vessel would normally be considered the 'stand on vessel' in an encounter between a deep-draughted vessel showing the black cylinder and a trawler showing two cones apex together?

With the display of both day signals it must be assumed that the deep-draughted vessel is constrained by her draught and that the fishing vessel is engaged in fishing operations. The fishing vessel becomes the 'stand on' vessel because the deep-draughted vessel could always stop, and take all way off (Rule 18(d)). (Unless overtaking.)

14. What would be your course of action as officer of the watch on sighting a vessel aground, right ahead?
 - (a) Take all way off own vessel.
 - (b) Inform the Master of the vessel.
 - (c) Operate echo-sounding equipment.
 - (d) Check the position of both vessels.
 - (e) Call up the vessel aground, and ascertain draught and time of grounding (for tide purposes).
 - (f) Navigate with extreme caution (Rule 8(e)).
15. You encounter a deep drafted vessel, which exhibits a black cylinder, three points on your own port side. After taking a series of compass bearings you ascertain that risk of collision exists. What action would you take?

I would be expected to avoid impeding the navigation and the safe passage of the vessel constrained by her draft. If the circumstances of the case permit, probably reduce my own vessel's speed in ample time and allow the larger vessel to pass ahead.
16. A power-driven vessel is stopped on the water, under way but not making way. Will she turn out any of her navigation lights?

No. She should still comply with all regulations concerning the display of masthead and sidelights, together with the stern light. (Rule 23(a).)
17. What is the fog signal for a pilot vessel at anchor, on station?

Rapid ringing of a bell in the forepart of the vessel for about 5 seconds, and, if over 100 m in length, a gong signal sounded in the afterpart of the vessel all at intervals not more than 1 minute. She may also sound an identity signal of four short blasts.
18. If a single white light is seen, to what types of vessel might it apply?
 - (i) A sailing vessel or power-driven vessel, as seen from astern – stern light.
 - (ii) A vessel less than 50 m in length at anchor.
 - (iii) A small boat under oars, or under power when its length is less than 7 m and speed under 7 knots.
 - (iv) A life raft showing the single white light on the outside of the canopy. (Rules 22, 30, 25(d)(ii) and specifications for approved life rafts.)
19. A warship is engaged in exercises with submerged submarines. What signal in the international code flags would you expect to be displayed by the surface craft?

'NE2' – 'You should proceed with great caution; submarines are exercising in this area' (*Mariners Handbook*).
20. A vessel is engaged in fishing with nets and lines extending across the bow of your vessel (not trawling). You are restricted in your

movements by the proximity of land masses and shoals and you are forced to cross over the fishing nets. What precautions would you expect to take?

- (a) Stop the vessel's propeller when passing over the line of nets.
 - (b) Cross the line of nets as near to 90° as possible.
 - (c) Inform the Master of the vessel.
 - (d) Attempt to pass between two buoys (fishing buoys often support the nets).
21. What is the recommended minimum safe passing distance to clear an oil rig?
500 m around the rig, measured from each point of rig's outer edge (*Annual Summary Notice to Mariners*, or *Mariners Handbook*).
22. How would a vessel engaged in dredging indicate to other vessels the obstructed area, by day?
The dredger would display two black balls in a vertical line on the side where the obstruction exists. This signal would be displayed in addition to the ball, diamond, ball signal, showing that the dredger is a vessel restricted in its ability to manoeuvre, and the two black diamond shapes, exhibited to indicate the clear area.

IALA MARITIME BUOYAGE SYSTEMS 'A' AND 'B'

An acceptable worldwide buoyage system is not a new idea, and in 1973 the Technical Committee of the International Association of Lighthouse Authorities (IALA) attempted to provide such a system. The results showed that agreement on a single system could not be immediately achieved, but in conclusion found that an alternative double system 'A' and 'B' was in fact a practical proposition (Figure 5.44).

The rules governing the two systems being very similar, it was possible to combine them to form the IALA Maritime Buoyage System, as we now know it. The system applies to all fixed or floating marks, other than lighthouses, sector lights, leading lights and marks, light vessels and lanbys.

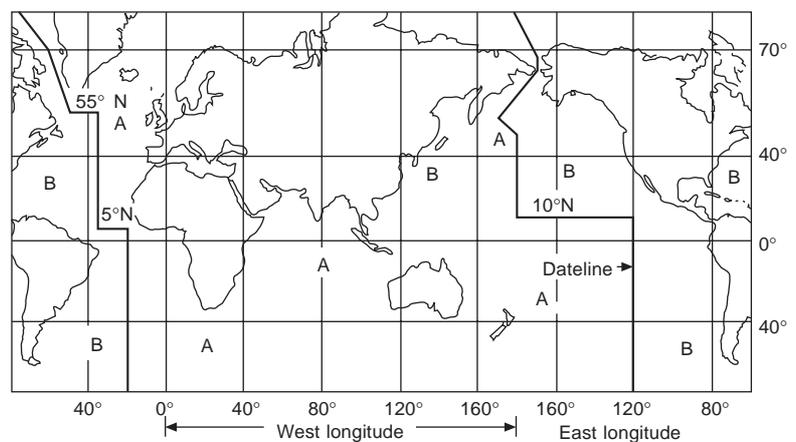


Figure 5.44 IALA maritime buoyage – areas covered by 'A' and 'B' systems.

It serves to indicate the centre-lines of channels and their sides, natural dangers such as sandbanks, as well as wrecks (described as new dangers, when newly discovered), and also areas where navigation is subject to regulation.

How the Systems Work

Each of the 'A' and 'B' systems comprises simplified lateral marks (port and starboard channel marks) and cardinal marks to be used in conjunction with the mariner's compass. The shapes of buoys of which there are five, are common to both systems: can, conical, spherical, pillar and spar. In the case of can, conical, and spherical shaped buoys, these shapes indicate the side on which the buoy should be passed. The pillar and spar buoys provide indication to the mariner by colour and topmark, not by shape (see Figures 5.45 to 5.48).

Lateral marks are generally used for defining the navigable channel in and out of harbour. Port and starboard buoys are used in conjunction with the conventional direction of buoyage.

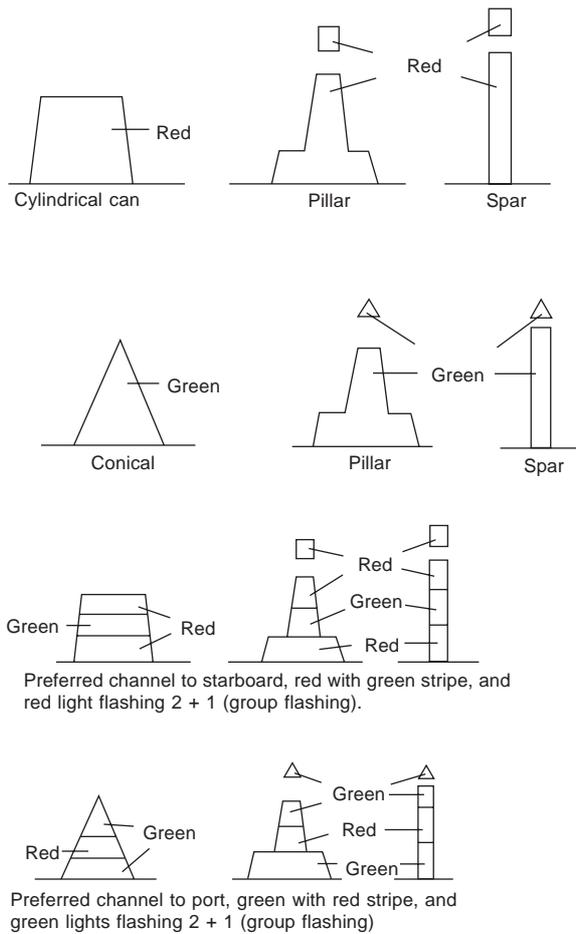


Figure 5.45 Buoys, System 'A'. Lights when fitted, red for port and green for starboard, have any rhythm other than the composite group (2 + 1) as used for preferred channel marks.

Lateral marks employed in system 'B' are similar shaped buoys but opposite in colour namely 'green for port', red for starboard.

Figure 5.46 Preferred channel marks, System 'A'.

Figure 5.47 Buoys, System 'B'. Lights when fitted, green for port and red for starboard, have any rhythm other than the composite group (2 + 1) as used for preferred channel marks.

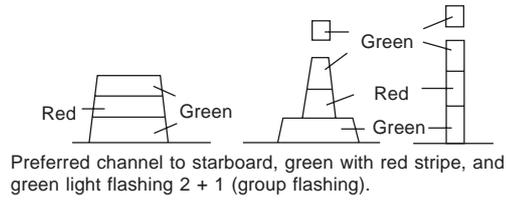


Figure 5.48 Preferred channel marks, System 'B'.

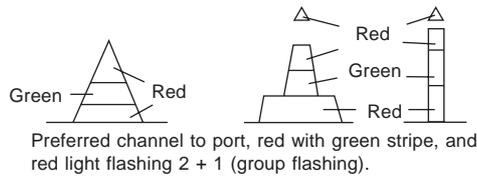
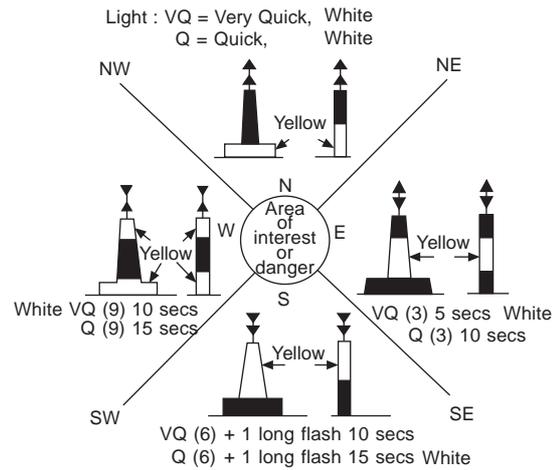


Figure 5.49 Cardinal marks.



Cardinal marks are to be used by the mariner as guides or as an indication where the best navigable water may be encountered (Figure 5.49). They are used in conjunction with the mariner's compass, e.g. the mariner would be expected to pass northward of a north cardinal mark. Topmarks and a colour scheme of black and yellow go to indicate the distinction and intention of the buoy during the hours of daylight. Lights are always white, and the rhythm distinctive to separate north, south, east and west. (The purpose of the long flash in the rhythm of the south mark is for identification from the other cardinal marks.)

Safe water marks, isolated danger marks, and special marks are illustrated in Figures 5.50 and 5.51, and UK buoys in Figure 5.52.

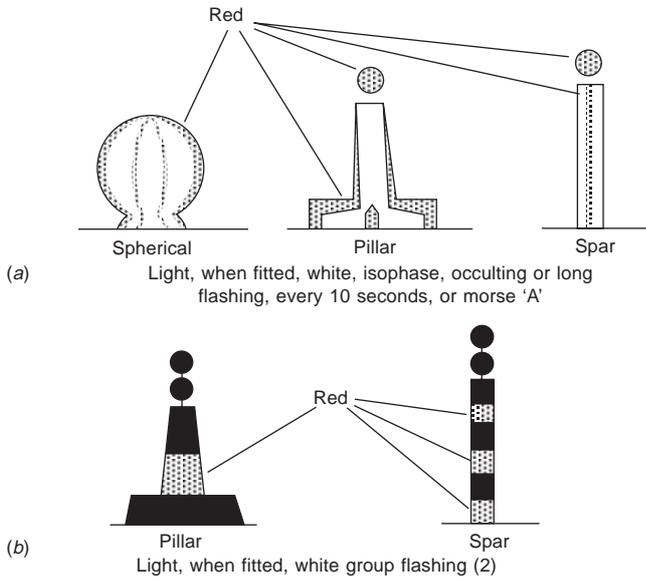
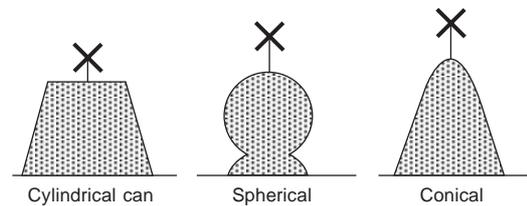


Figure 5.50 (a) Safe water and (b) isolated danger marks.



If can, spherical or conical shapes are used, it must be an indication of the side on which the buoys are to be passed:

- Can shape, to be left on the mariner's port side.
- Conical shape, to be left on the mariner's starboard side when travelling with the direction of buoyage
- Spherical shaped buoys, in general, are passed either side. Mariners should navigate all buoys with direct consultation to the chart affecting the area and with regard to the observance of good seamanship.

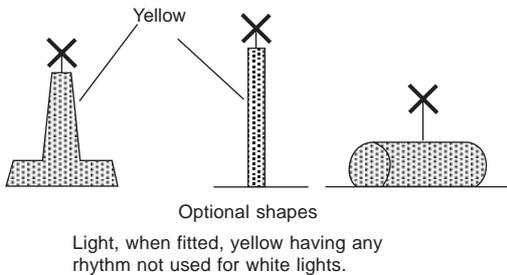


Figure 5.51 Special marks.

Local direction of buoyage is the direction to be taken by the mariner when approaching a river estuary, harbour or other waterway from a seaward direction.

General direction of buoyage is a direction about a land mass, as predetermined by the buoyage authorities (Figure 5.53). The general direction for any given area may be obtained from the sailing directions or ascertained from the navigational chart.

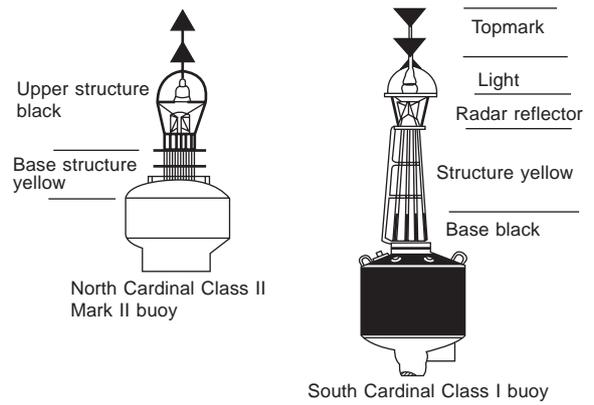


Figure 5.52 Types of buoy in use about UK coast.



Figure 5.53 Direction of buoyage about UK.

EMERGENCIES



COLLISION

Whenever a collision occurs, the vessel's sound watertight integrity is likely to suffer, and personnel may experience considerable shock, whether the collision is with another vessel, land mass or ice floe. No precise set of actions can be laid down for this situation, though certain general rules are applicable. A suggested line of action is the following:

1. Sound general emergency stations.
2. Stop main engines in most cases. Circumstances may dictate that if one vessel is embedded in another, it is desirable to maintain a few revolutions on the engines, since a rapid withdrawal from a gashed hull could leave a massive hole, which would allow the passage of considerable water. This could result in the immediate sinking of the stricken vessel. While one ship is embedded in the other, it is acting as a plug and slowing the ingress of water through the area of damage.
3. Close all watertight and fire doors, and start bilge pumps on affected areas.
4. Assess the extent of the damage, as follows:
 - (i) By visual inspection of the area of impact. Estimate tonnage of water inside the vessel, and rate of water entering the vessel because of the damage.
 - (ii) By estimating size of the damaged area and its position in relation to the water line. There may be temporary solutions, e.g. collision patch.
 - (iii) By stability assessment. If cargo is affected, check the permeability and the subsequent loss of buoyancy, together with change in trim. Assess immediate effect on GM and the continued effect on GM.
 - (iv) Consider additional factors, such as the risk of fire, gas or toxic fumes in the vicinity of the two vessels; or possibility of explosion resulting from withdrawal from the other vessel.

- (v) Check for casualties or missing persons aboard your own vessel
- 5. Establish communications and see that emergency procedures are operated, as follows:
 - (a) Damage control party mustered at the incident scene.
 - (b) Emergency generator activated if required.
 - (c) Pumping arrangements set to gain maximum efficiency, with possible use of ballast pump instead of bilge pump.
 - (d) Communications officer to stand by.
 - (e) Engine room facilities kept on standby.
 - (f) Position on chart established and safe port options investigated.
- 6. The Master of every vessel colliding with another vessel is obliged to provide the other vessel with the following particulars:
 - (a) The name of his ship.
 - (b) The port of registry of his ship.
 - (c) The port of departure.
 - (d) The port of destination.

The Master is further obliged to render all possible assistance to the other vessel.

- 7. Depending on the amount of damage and general circumstances, it must be assumed that at some stage a decision to abandon or not to abandon will be taken. In either case the communications officer will probably be ordered to despatch an 'urgency' signal, which may or may not be followed by a 'distress' message.
- 8. Many variable factors will come into play over the period from impact up to the time that any decision is taken to abandon the vessel, and these should be given full consideration when deciding any course of action:
 - (a) The weather conditions at the time and in the future.
 - (b) The expected time that vessels will stay afloat when taking in water.
 - (c) The risk to personnel from fire or explosion by remaining aboard.
 - (d) The odds of saving the vessel by beaching or steaming into shallow waters.
 - (e) The question of pollution, especially in coastal waters.
- 9. The Master should report the casualty as soon as practicable, in any event within 24 hours of the ship's arrival at the next port. This report should be made to the Marine Accident Investigation Branch (MAIB) and should include a brief description of the incident, stating the time and place of its occurrence, together with the name and official number of the vessel, the next port of call and the position of the ship at the time of making the report. An entry should also be made in the official deck log book describing the sequence of events surrounding the collision.

Masters would under normal circumstances inform their owners at the earliest possible time after the collision, bearing in mind that repairs will probably have to be carried out immediately to render the vessel seaworthy.

10. Assuming that the vessel remains afloat, efforts should be made to prevent any increase in damage or further flooding. Should the vessel still be capable of manoeuvring, then she should do so under the correct signals, either NUC or International Code Flags.

Any oil leakage should be reported in accordance with the pollution convention requirements regarding notification to the Marine Pollution Control Unit (MPCU).

FLOODING

The function of the outer shell, the hull, of a ship is to keep the water out and provide the displacement of water, and hence the upthrust, to keep the ship afloat. Exceptional circumstances may make this practical application of Archimedes Principle difficult to sustain. These circumstances may be caused from one or more of the following:

- (a) Collision with another vessel, or ice.
- (b) Collision with the land or some object secured to the land.
- (c) Collision with an underwater object.
- (d) Explosion aboard the vessel.
- (e) Stranding and/or beaching (grounding).
- (f) Military engagement.
- (g) Fire.

To meet the above dangers, shipbuilders have incorporated in the ship's structure such items as the collision bulkhead situated well forward, the cellular double bottom system over the keel area, together with increased scantlings where considered necessary for the trade. However, no company or shipbuilder can foresee the future and guard against the unexpected such as internal explosions or collision with underwater objects.

Main Dangers

The first and foremost hazard is the loss of watertight integrity in one or more compartments and the subsequent loss of internal buoyancy from the damaged areas. The immediate action of closing all watertight doors throughout the ship's length will reduce further loss of buoyancy.

The development of consecutive flooding throughout the vessel's length is a principal cause of foundering. Should this flooding occur, the total loss of internal buoyancy must be accepted as a probability, and the only course open is to delay the inevitable in order to get survival craft clear.

If total flooding of the vessel cannot be avoided, the decision to abandon the sinking vessel should be made in ample time for survival craft to clear the area. The dangers of lifeboats and rafts being dragged under by a sinking ship are obvious. Equally dangerous is the mast rigging and high superstructures fouling survival craft close to a capsizing hull.

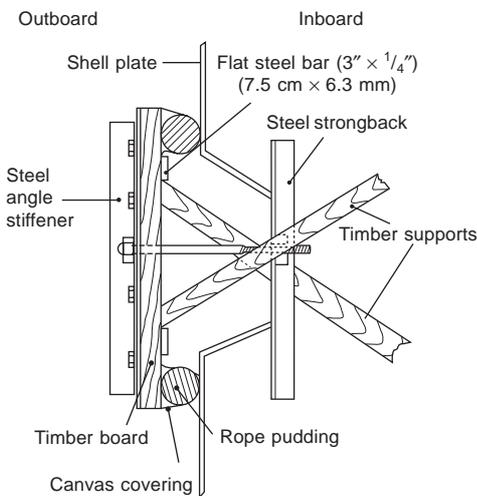


Figure 6.1 Collision patch.

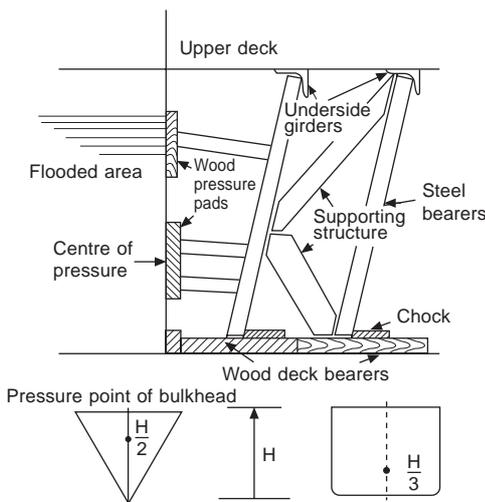


Figure 6.2 Shoring up a bulkhead. Assuming a space aboard the vessel to be flooded then the decision to 'shore up' may be made, regarding the reverse side of bulkheads, affecting the flooded area.

The positions of shores will be determined by the pressure points calculated approximately by:

$$\frac{H}{2} \text{ for ship-shape bulkheads;}$$

or by $\frac{H}{3}$ for box-shaped bulkheads where H is the vertical height.

Possible Solutions

For a ship holed above the water line, build a collision patch (Figure 6.1) over the damaged area, and investigate safe port options with repair facilities. Note any deviation of the ship, and note times and position in the ship's log. Pump out the bilges and take regular soundings. Avoid bad weather if at all possible. Inform owners as soon as possible.

For a ship holed or cracked on or near the waterline, start the bilge pumps in the area affected, and pump out ballast water fore and aft to raise the vessel bodily. This should bring the damaged area above the waterline. If not, provide the vessel with a list on the opposite side to the damage.

Construct a collision patch on the outside, and/or a cement box on the inside, of the damaged plates. (This will depend on the size of the damaged area.) Have any temporary repairs kept under constant watch, with any adverse change being immediately reported. Check continually on soundings about the damaged area, especially in adjacent compartments.

Look at stability data for the compartment and check means of containment in adjoining spaces. Obtain charted position and investigate safe port options. Inform owners of the need for immediate repairs, together with an assessment of damage.

Instigate temporary repairs if possible and be prepared to despatch an 'urgency' signal should the situation worsen. Keep a close watch on weather reports and inform passengers and crew of the situation.

If the damage is severe, and the ingress of water is of massive proportion, loss of that compartment must be accepted. Attempts should be made to contain the flooded area. The shoring up of the bulkheads (Figure 6.2) must be considered, or deliberate part flooding of the adjoining compartments, provided the buoyancy of the vessel is adequate.

The weight of water entering the compartment will depend on the permeability of the cargo in that compartment. This fact alone may be the saving grace of the damaged vessel. However, in any case the normal procedures for investigation of safe port options must be made at the earliest possible moment, together with the despatch of an 'urgency' signal, which may be followed by a distress signal if the situation becomes beyond control.

The damaged stability data should be investigated, and a speedy conclusion reached. If the vessel is sinking, then this fact should be determined without delay to provide maximum time for abandoning ship. The amount of water entering the vessel can be found approximately from the following formula:

$$4.3A\sqrt{D} \text{ tonnes/per second}$$

where A represents area of damage and D represents the depth of the damage below the waterline. This formula should be used as a guide, but not accepted as being totally accurate for every case.

ABANDONMENT FROM THE VESSEL

This situation should only be considered in two circumstances: when all measures to keep the vessel afloat have failed and the ship is in a sinking condition; or when, although the vessel is floating, it is no longer possible to remain aboard because loss of life could result from heat, smoke or some other adverse condition. The decision to abandon ship must be made by the Master or officer in charge after assessing all the facts of the situation. The decision will be influenced by some of the following points:

1. Weather conditions.
2. Stability of the vessel in distress.
3. Geographic position.
4. Lifesaving appliances available and their condition.
5. Casualties present, and expected, by remaining aboard or abandoning the vessel.
6. Numbers of persons to consider and their experience.
7. Range of search and rescue craft and the time factor.
8. Communications with rescue services.
9. The danger of explosion.
10. The danger of the situation worsening, and the time when abandonment can be safely carried out being missed.

The order to abandon ship must be given by 'word of mouth', by the Master or the officer in charge, or a designated deputy (a responsible officer if such a person is still available). Loud hailers, public address systems, walkie-talkie radios etc. may be used to ensure everyone hears the order. Certain equipment, such as PA systems, need a source of power, and persons finding themselves in this situation should be aware that in an emergency power may not be readily available.

Training and Drills

Warships carry out regular exercises in the methods of abandoning ship, but this is unfortunately not the case with many merchant vessels. Officers should be alive to the fact that simple briefings at the regular boat and fire drills could very well help in an emergency. Such briefings could include:

- (a) The stowage positions of spare lifejackets.
- (b) The duties of the boats' crews while awaiting the orders to abandon, e.g. gathering extra blankets, water and food.
- (c) The need for any motorboats launched to collect other survivors and see that other survival craft come together.
- (d) The closing of watertight doors, before leaving one's post, so buying additional buoyancy time by common-sense actions.
- (e) Instruction of uncertificated lifeboat men in the launching methods of survival craft.

Cause and Consequence

Experience has shown that ships have had to be abandoned after one or

more of the following accidents: collision, explosion, or fire. Fire will often follow a collision or explosion, and in either case the loss of the ship may be imminent.

Once survival craft are launched, it is the duty of the person in charge of such craft to put sufficient distance between the craft and the sinking vessel so that masts, funnels and rigging etc. will not fall on the craft and it will not be affected by the suction from the ship as she goes down. Survival craft are expected to wait at the scene of the sinking, if this is a practical proposition, for the purpose of picking up other survivors and to be picked up themselves by rescue craft, especially if the communications officer has been able to transmit a distress message and have it acknowledged before the sinking.

Tankers

The obvious danger with this type of vessel is from oil on the water, and the greater risk is burning oil on the surface. In either case the danger occurs to individuals jumping into the water. Swallowing oil and sea water causes choking and eventually drowning. For those who remain afloat there is the further danger of exhaustion and suffocation.

Possible solutions to these hazards are limited but swimming under water to clear smaller patches of oil on the surface should not be ruled out. Should the person have to come to the surface for air in the middle of oil patches, he may find that the breast stroke in swimming is better suited to clear away the oil film than, say, the crawl stroke.

It is a far better course of action to abandon ship by means of the survival craft if at all possible, especially if such craft include the totally enclosed type of lifeboat. Protection by the enclosed canopy from burning oil is part of their design, and more sophisticated types of survival craft have built-in cooling water sprays and self-righting capabilities.

Passenger/Ferry Vessels

With this type of vessel the real danger of panic setting in among passengers must be the Master's biggest worry once the decision to abandon has been made. Regular drills will play a major part in quelling any panic before it begins, and also provide the passengers with the necessary reassurance that the ship's personnel are trained and prepared to handle such emergencies.

Experience has shown that extensive loss of life may well occur if people abandon ship individually, and also if passengers without the required skills attempt to launch survival craft. In many cases the simple rules of warm clothing, donning the lifejacket correctly, and knowing where to go have shown themselves to be essential to survival.

With large numbers of passengers, the control of whom can easily get out of hand, it is suggested that assembly points like public rooms be allocated at the beginning of the voyage. These will allow the relatively safe and calm assembly of passengers, who can be despatched at controlled intervals to the embarkation deck. This system also allows crew to turn

out the boats and make survival craft ready for launch without being hindered by frightened people.

Roll on–roll off Vessels

The essential feature of this type of vessel is the large amount of open space on the vehicle decks, and the main danger, if the stowage area is holed to any extent, that the speed with which water may flood the vessel could be critical. The time in which to take the decision to abandon the vessel and launch survival craft will be limited.

The design of these vessels is generally such that they have a very large GM compared with the conventional type of vessel. They also tend to have large freeboards, with vehicle decks situated higher than the waterline. All these features reduce the risk of being holed below the waterline and in the stowage spaces but the possibility always exists, especially if a vessel has grounded, and the double bottom tanks and the tank tops have been pierced, allowing water to penetrate direct into the stowage areas.

A speedy assessment of damage would be essential with a roll on–roll off vessel, and once the decision to abandon has been taken, then swift, positive action would be required from all personnel. Abandoning the vessel by bow and stern doors, as well as by shell doors, should not be ruled out if the circumstances of the case admit, and if a source of power to operate them is still available. Individual abandonment should be avoided, in view of the high freeboard, unless no alternative is left. Use should be made of disembarkation ladders, lifelines to boats etc. as a realistic alternative to direct entry into the water from the freeboard deck (upper deck).

Scrambling Nets

Nets could be usefully employed in many types of rescue, especially on high freeboard vessels and where there are large numbers of people to consider. Nets may not always be available at short notice and improvisation in the way of gangway or cargo nets may be a useful alternative. When nets or other similar rescue equipment is to be used for the recovery of survivors, the physical condition of persons to be rescued should be considered, e.g. the injured and stretcher cases.

RESCUE AND RECOVERY OF SURVIVORS

Circumstances affecting the rescue of survivors will vary considerably but might be categorised into three groups:

- (a) Recovery from survival craft or wreckage.
- (b) Recovery from the water.
- (c) Recovery from parent vessel before she sinks.

Recovery from Survival Craft

1. Prepare hospital and other reception areas to receive casualties. Provide

medical aid for burns, oil cleansing, and treatment of minor injuries with bandages, adhesive dressings and splints. Expect to treat for shock and hypothermia – blankets, warm clothing, hot drinks and stretchers should be made ready.

2. Rescue apparatus in the way of scrambling nets and boarding ladders should be rigged overside, together with a guest warp. Derricks and/or deck cranes may be swung overside to recover survival craft, provided the safe working load of the lifting gear is adequate. These may be used with or without cargo nets secured to the end of cargo runners. Cargo baskets may be useful for lifting injured people from boats.
3. Try to manoeuvre the rescue vessel to windward of the survival craft to create a lee, to aid recovery.
4. Establish communications with the survival craft as soon as is practical. Acknowledge distress signal flares by sound or light signals.
5. Have plenty of long heaving lines available, and also the rocket line throwing gear.
6. Maintain normal bridge watch, checking navigation hazards in the vicinity. Display correct flag signals and keep other shipping, as well as the coastal radio station, informed of movements and situation.

Recovery from the Water

1. Preparation should be as in (1) and (3) above.
2. Depending on weather conditions, the best method of recovering a person or people from the water would be by use of own boats. A ship's rescue boat is desirable, and this should be launched within sight of the survivor(s) in a lee made by the parent vessel.
3. Injured parties should be hoisted aboard individually with the aid of stretchers.
4. The condition of persons in the water, especially after a lengthy immersion, will be poor. Assistance may be required by ship's personnel to bring survivors aboard. Crew members should always wear safety harness and lifejacket in this situation, or they may need rescuing themselves.
5. Shooting the rocket line towards survivors may prove a worthy option if the state of the sea is so dangerous that it would be foolhardy to attempt to launch a ship's boat.
6. Persons in the water without flotation aids cannot be expected to remain afloat for long periods. It might be necessary to provide some form of buoyancy, such as a lifebuoy.

Recovery from Parent Vessel

1. Should an order to abandon ship be given while a rescue vessel is on the scene, it is an obvious move to attempt to recover personnel direct from the stricken vessel.
2. This operation could be carried out basically in two ways: by bringing the rescue vessel alongside the ship in distress or by use of the rescue ship's boats. Each case has its merits. A Master in a recovery operation

For further reference, marine students are directed to Volume III, The Command Companion of Seamanship Techniques DJ House, ISBN 0 7506 444 35.

would probably not endanger a tanker full of aviation spirit by drawing alongside another vessel on fire. In this case he would probably use his ship's boats. But, say, there were two vessels of different freeboards. The rescue vessel could manoeuvre her fo'c'sle head into contact with that of the distressed vessel, and allow those being rescued to cross via the two fo'c'sle head areas

STRANDING

This is physically the same action as beaching, but with the significant difference that beaching the vessel is an intentional action and under comparatively controlled conditions, whereas stranding is accidental. Circumstances will vary with different ships, but selecting a convenient position to 'set down' will in all probability never arise. In consequence, the double bottom area of the vessel will probably suffer considerable damage, especially if the ground is rocky.

The method of procedure to follow on stranding can only be an outline, when one considers how circumstances may vary. Here are some suggestions:

1. Stop engines.
2. Sound emergency stations.
3. Close all watertight and fire doors.
4. Damage control party to assess damage. This must include sounding around the outside of the hull and checking the available depth of water.

All of the vessel's tanks, especially double bottoms and bilges, should also be sounded and visually inspected wherever possible, air pipe and sounding pipe caps being well secured after the soundings have been obtained. This will prevent oil pollution as water pressure forces oil upwards through the outlet pipes above deck.

5. Check position on the chart and observe depths of water around the vessel.
6. The Master should consider refloating, though that depends on the extent of the damage especially to tank tops. The tides should be assessed, and ballast tanks, together with additional weight (including fresh water), viewed for dumping in order to lighten ship. Damage stability data should also be consulted. There may be value in dropping an anchor underfoot to prevent a damaged ship from sliding off into deep water.
7. Consider whether assistance is required in the form of tugs to drag the vessel astern clear of the beach into deeper water.
8. As soon as practical, enter a statement into deck log book and inform owners and the Maritime and Coastguard Agency (on state of seaworthiness).

BEACHING PROCEDURE

Beaching is defined as taking the ground intentionally, as opposed to accidental stranding. It is normally carried out for either or both the following reasons:

1. to prevent imminent collision;
2. to prevent loss of the vessel when damaged and in danger of sinking, damage having occurred below the waterline causing loss of watertight integrity. The intention is to carry out repairs in order to refloat at a later time.

Should time and choice be available, the mariner should attempt to beach the vessel on a gentle sloping beach, which is rock free and ideally with little or no current. If possible it should be sheltered from the weather, free of surf action and any scouring effects.

Advantages and Disadvantages for 'Bow' or 'Stern' Approach

When approaching bow-on, the obvious advantage is that a clear observation of the approach can be made and the vessel will probably have a favourable trim. The propeller and rudder will favour the deeper water at the stern, while the strengthened bow would cushion any pounding effects. The disadvantages of this approach are that the vessel is more likely to slew and the need for anti-slew wires used in conjunction with anchors, may become necessary. Also it is difficult to lay ground tackle from this position, to assist with the refloating. In the majority of cases stern power would be used for refloating the ship and the average vessel normally operates with only 60 per cent of the ahead power, when navigating stern first.

Beaching stern first is just as effective, provided that time allows. It is easy to do, in the form of a mediterranean moor but allows the propeller and rudder to close the bottom with the obvious risk of additional damage. The vessel may also prove difficult to 'con' when navigating stern first.

Actions Prior to Beaching

Provided that time and circumstances allow, the vessel to be beached should take on full ballast. This will make the operation of re-floating that much easier.

Both anchors should be cleared away and made ready to let go. Care should be taken to lay anchors and cables clear of the position that the vessel is expected to come to rest, so minimizing the bottom damage, if this is possible. Additional use of a stern anchor, if the ship is so equipped, would become extremely beneficial on the approach, with the view to refloating later.

On Taking the Ground

Drive the vessel further on and reduce the possibility of pounding. Take on additional ballast and secure the hull against movement from weather and sea/tide.

Take precautions to prevent oil pollution. This can be achieved by discharge into oil barges, or transfer within the vessel into oil-tight tanks. Another alternative would be encircling the vessel with an oil pollution barrier, if one can be obtained quickly enough and positioned effectively.

Damage reports should be made to the Marine Accident Investigation Branch (MAIB), together with a 'general declaration', the Mercantile Marine Office being informed and entries made into the Official Log Book.

DECK DEPARTMENT CHECKLIST FOR WATERTIGHT INTEGRITY OF HULL
FOLLOWING GROUNDING OR BEACHING

1. Check for casualties.
2. Assess internal damage by visual inspection where possible. (Special attention being given to the collision bulkhead and the tank tops.)
3. Look for signs of pollution from possible fractured oil tanks.
4. Make internal sounding of all double bottom and lower tanks, followed by a complete set of tank soundings at the earliest possible time.
5. Sound for available depth of water about the vessel, especially around stern and propeller area.
6. Check position of grounding on chart. Determine the nature of the bottom and expected depth of water.
7. Obtain damage reports from all departments.
8. Determine state of tide on grounding, together with heights and times of the immediate high and low waters.
9. Order communications officer to stand by.
10. Check condition of stability if the vessel has suffered an ingress of water.
11. Instigate temporary repairs to reduce the intake of any water, and order pumps to be activated on any affected areas.
12. Cause a statement to be entered into the deck log book, with a more detailed account to follow.

ENGINE ROOM DEPARTMENT CHECKLIST FOR MACHINERY SPACES
FOLLOWING GROUNDING OR BEACHING

1. Check for casualties.
2. Assess damage inside the engine room and pump room and report to the Master.
3. Make ready fire-fighting equipment in case of fire outbreak.
4. Prepare pumps to pump out water from engine room spaces.
5. Inspect all fuel and steam pipes for signs of fracture. A build-up of oil represents a fire hazard and must be located and corrected as soon as possible. Regular checks on bilge bays must be continued for a minimum period of three days after taking ground.
6. Inspect all piping, valves and auxiliary equipment, before reporting to the Master on conditions.
7. Should water be entering the engine room, instigate immediate temporary repairs to reduce the ingress of water, and start the pumps on the affected areas.

The general alarm should be sounded before grounding or beaching, but if this has not been done, it would become the first action in the above lists.

WATERTIGHT DOORS

There are many designs of watertight door and watertight hatch, the most common being those closed manually by means of 'butterfly clips' or 'double clips and wedges' (dogs), which are operable from either side of the door (Figure 6.3). The disadvantage of this type of closure is that it takes considerable time to secure. In an emergency it may even prove impossible to secure against water pressure on one side.

Regular and extensive maintenance is required on the clips to ensure they are free in movement and can be easily operated. Oiling and greasing of moving parts, especially of weather-deck hatches and doors, becomes an essential part of any planned maintenance operation. Regular inspection and periodic renewal of the hard rubber seal around the perimeter of the access door will ensure watertight integrity.

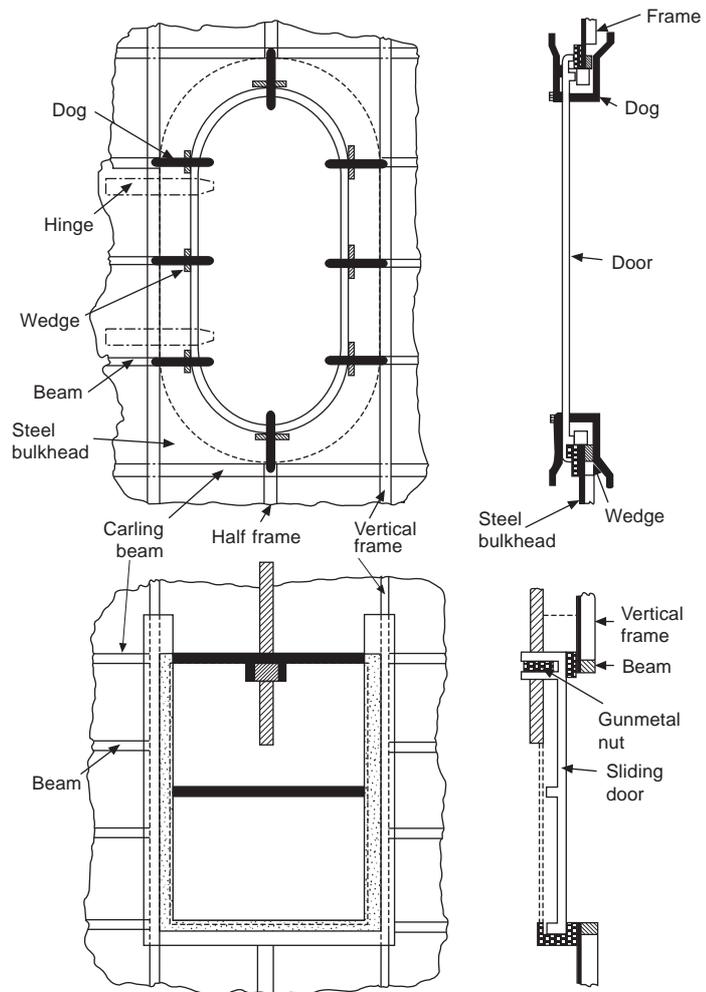


Figure 6.3 Watertight door construction.

Where electrical, hydraulic (Figure 6.4) or pneumatic systems are installed, as in passenger vessels, each watertight door should be equipped with audible and visual alarms effective on both sides of the door, a local emergency stop control, a manual operation system located close to the door, and emergency worming gear operative from an external point on deck. The obvious advantage of a bridge controlling point, which operates all doors simultaneously, increases the speed at which watertight integrity is achieved throughout a vessel, on all decks. The bridge control is fitted with a light 'tell tale system', which tells the operator at a glance which doors are closed and which are open. When operating in a guide system under power, they are also effective, even against an inflow of water pressure. Should loss of power occur, then similar results may be achieved by external manual operation.

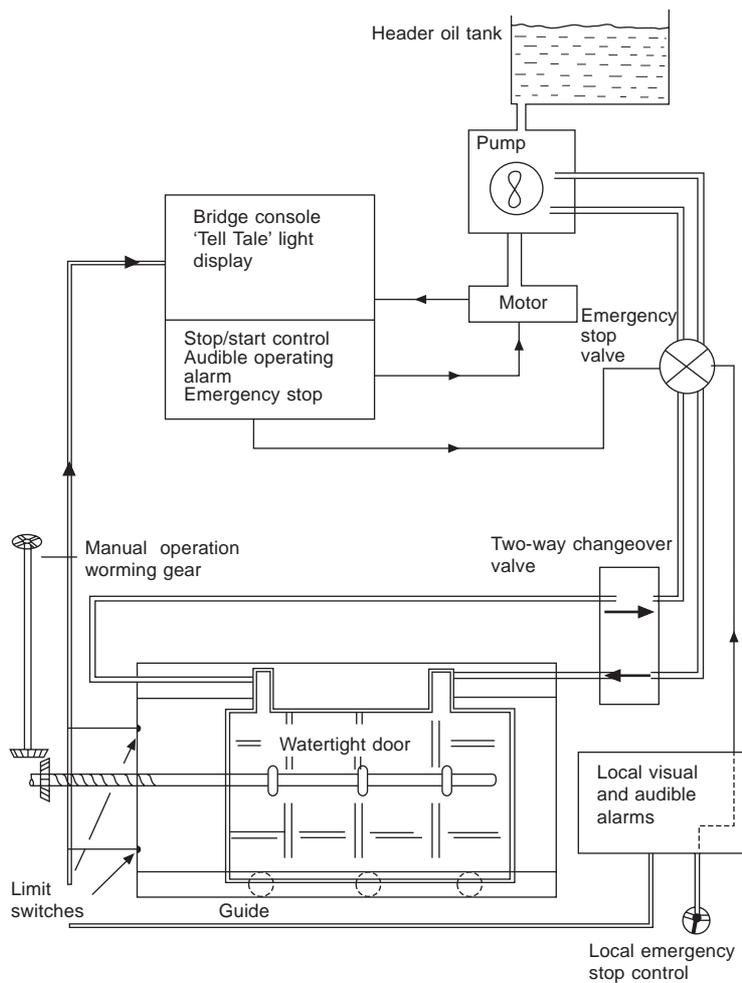


Figure 6.4 Control of hydraulic sliding watertight door.

DRYDOCK PROCEDURE

Plates 20 and 21 illustrate a ship in drydock.

*Chief Officer's Duties**Preparation and precautions for entry*

1. All hatches and beams should be in the stowed position to ensure continuity of strength throughout the ship's length.
2. All derricks and cranes should be down and secured, not flying.
3. Any free surface in tanks should be removed or reduced to as little as possible, either by emptying the tank or pressing it up to the full condition.
4. Stability calculations should be made to ensure adequate GM to take into account the rise of 'G' when the vessel takes the blocks.
5. Consult dock authorities on draught of vessel and trim required. Generally a small trim by the stern is preferred, in normal circumstances.
6. Inform dock authorities in plenty of time of any projections from the hull of the vessel, as indicated by drydock plan.
7. Sound round all ship's tanks before entering the dock, to be aware of quantities aboard. Note all soundings in sounding book.
8. Sound round all tanks once the vessel has taken the blocks, to ensure a similar stability state when leaving the drydock.
9. Lock up ship's lavatories before entering the dock.
10. Ensure adequate fenders are rigged for entry into the dock and that dock shores are correctly placed against strength members once the vessel is positioned. If it is the custom in the graving dock, arrange for fo'c'sle head party to position shores on one side and the stern party to deal with the other side.
11. If required, endeavour to have the vessel cleaned and scrubbed as the dock water is pumped out.



20. Removal of ship's propeller in drydock. The chain block arrangement and support rigging for changing the propeller, or inspecting the tail end shaft, may be seen.



21. On the blocks in drydock the hull lines are clearly defined, with both anchors walked back either side of the bow.

When drydocking with cargo aboard

12. Inform dock authorities where to position extra shores or blocks to take account of additional stresses caused by the weight of cargo aboard.
13. Give cargo areas a lock-up stow whenever possible.

When in dock

14. Obtain telephone/electricity/and water pressure fire line garbage and sanitation facilities as soon as possible.
15. Have documentation ready, inclusive of repair list, for dock personnel.
16. Should tank plugs need to be removed, sight their removal and retain the plugs for safe-keeping. Ensure that plugs are labelled after removal.

Draught and Trim

The vessel's required draught and trim will be decided by the drydock manager and the declivity of the drydock bottom. A small trim of between 12 in (30 cm) and 18 in (45 cm) is considered normal but will be dictated by circumstances. If a floating drydock is to be engaged, the drydock itself can be trimmed to suit the vessel, especially if the vessel has sustained shell damage.

Drydock Plan

This is a plan carried aboard the vessel which shows recommended positions for keel blocks and shores. Normally the frames are numerically indicated from aft to forward, and the strakes lettered from the centre-line out and upwards. Indicated on this plan will also be the position of any external projections from the hull, namely, echo-sounder units, stabilisers, scoops for condensers etc. Either a separate plug plan will be carried or the tank drain plugs will be indicated on the drydock plan.

Stability of Vessel

This is the responsibility of the vessel, and should be adequate to cope with the virtual rise of G as the vessel takes the blocks. The vessel should not be listed. Should damage be such that the vessel cannot counter an acquired list, then shoreside weights should be taken aboard to bring the vessel to an even keel.

Position of Shores

Side keel blocks are positioned in the drydock to offer additional support to keel blocks, especially for the broader beamed vessel.

Some drydocks will position *bilge shores* at the turn of the bilge, these are not to be confused with the above-mentioned side keel blocks. *Breast shores* are usually only rigged in graving docks where the sides of the dock are stepped.

Ideally the shores and blocks should be positioned at the intersections of frames and stringers. Side blocks should be placed at the intersection of an athwartship floor and a fore and aft member, such as an intercostal. Where the vessel is to drydock in a floating dock, then hydraulic cradle shores may be encountered. These are housed in side tanks set into the dock sides.

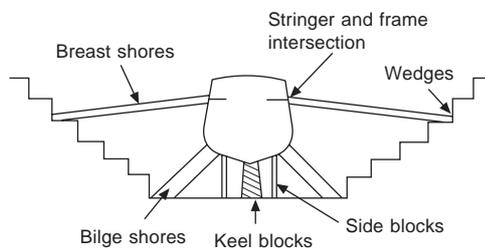


Figure 6.5 Positions of shores relative to stepped sides of graving dock.

Repair Lists

It is normal practice to carry out repairs when entering drydock, these repairs may be expedited by detailed work lists covering expenditure limits, work monitoring, state of survey, maintenance of classification, and protection of owners' interests.

To Calculate the Virtual Loss of GM

There are two methods for ascertaining the virtual loss of GM. In each of the two methods the force P must be known. Force P represents the

upthrust at the stern at the moment the vessel touches the keel blocks. The time the keel first touches the blocks until the vessel has taken the blocks overall is considered to be the critical period (Figure 6.6).

$$\text{Force P (tonnes)} = \frac{\text{MCTC} \times t}{L}$$

where MCTC represents the moment to change trim one centimetre,
t represents the trim in centimetres on entering the drydock,

L represents the distance between the centre of flotation and the vertical line of action of the P force, in metres.

The first method considers the movement of the metacentre (M):

$$\text{Virtual loss of GM} = \frac{P \times KM}{W}$$

The second method considers the movement of the centre of gravity (G):

$$\text{Virtual loss of GM} = \frac{P \times KG}{W - P}$$

Either of the two methods are acceptable when

W represents displacement of the vessel.

KM represents the distance between the keel and the metacentre,

KG represents the distance between the keel and the centre of gravity of the vessel.

MAN OVERBOARD

The actions of the officer of the watch and the ship will depend on the circumstances of each individual case. To take account of every eventuality would be impossible, but a general sequence of actions to take might be the following:

1. The alarm should be raised as soon as possible, once details of what has happened, are known.
2. The officer of the watch should take the following immediate action:
 - (a) Order helm hard over towards the side on which the man fell, before commencing a Williamson turn (Figure 6.7).
 - (b) Release the bridge wing lifebuoy and combined smoke/light (Plate 22).
 - (c) Stand by main engines to manoeuvre the vessel. (Do not stop engines unless the man in the water is in danger from the propeller.)

Point 'A' – man overboard

1. Rudder hard over to swing stern away from man.
2. Release lifebuoy
3. Sound 'emergency stations'.

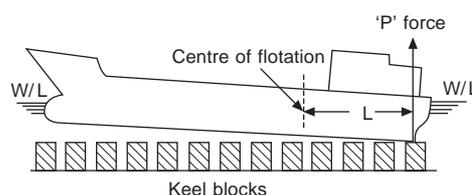


Figure 6.6 Drydocking – start of critical period.

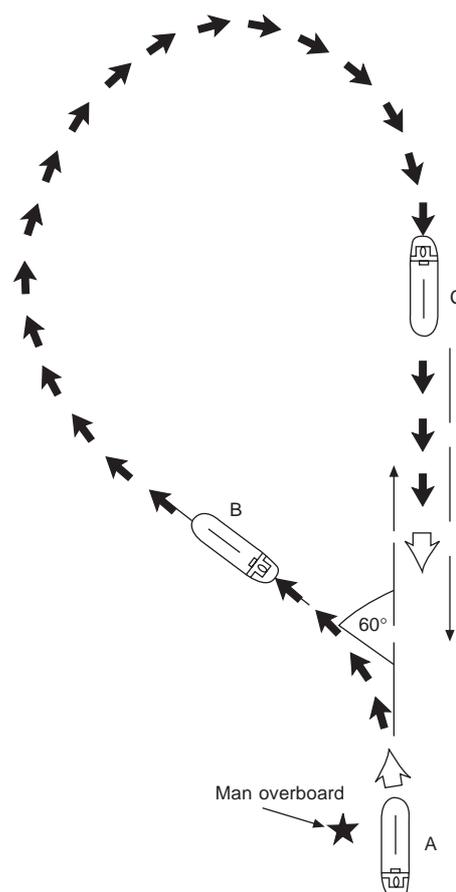


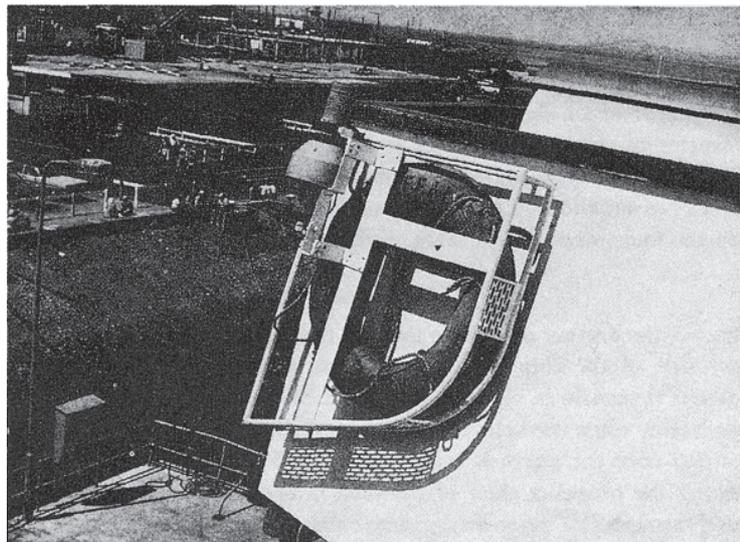
Figure 6.7 Williamson turn.

4. Main 'standby'.
5. Place lookouts.

Point 'B' (60° off original course), reverse rudder to same angle in opposite direction to reduce speed.

Point 'C' – ship on reciprocal course

1. 'Steady'.
2. Stop ship to pick up man.
3. Subsequently the officer of the watch should sound general emergency stations, as soon as it is practical and the Master should be informed of the situation. Lookouts should be posted at strategic points while the turning manoeuvre is proceeding, and a VHF radio warning sent to nearby shipping and coastal radio station. If they see him, lookouts should point at the person in the water until he/she is picked up or lost to sight. The officer of the watch should delegate personnel to display 'O' flag, and have a man ready to act as helmsman, if navigating on automatic pilot.
4. The emergency boat's crew should stand by and be ready to launch the rescue boat to effect recovery, weather permitting. The communications officer should be ordered to stand by, and be prepared to transmit an urgency signal.
5. An efficient and effective watch should be maintained at all times throughout the manoeuvre, especially if other shipping are near. A position should be noted on the chart as soon as possible after the alarm is raised.
6. The chief steward/catering officer or medical officer aboard should be ordered to prepare the hospital reception space. Advice may be needed for the treatment of shock and hypothermia.
7. The vessel's speed should be reduced as the Williamson turn is completed, and the following points considered:



22. Emergency bridge lifebuoy, for use in 'Man Overboard' emergencies, with combined light and smoke float attached. This one is secured in the stowage bracket on the after side of the port bridge wing.

- (a) Whether to start a search pattern, from which point and at what time, and what type of search pattern to use (probably sector search).
- (b) Whether to let go a second bridge lifebuoy and combined smoke/light. If the second lifebuoy is released when the vessel is on a reciprocal course, a reference line of search can be established between the first and second lifebuoys. This would be of considerable help to a search vessel and would provide an initial rate of drift over a greater area. However, when a second lifebuoy is released, the man in the water may assume that this is the first lifebuoy to be released and swim towards it. In so doing, he ignores the first buoy released and in confusion may drown through exhaustion while heading towards the second. (The combined smoke/light emits dense orange smoke for 15 minutes, and a light of 3.5 candela for 45 minutes.)
- (c) The sounding of 'O', 'man overboard', on the ship's whistle, to alert other shipping and reassure the man in the water that his predicament is known.

Factors influencing a successful recovery comprise weather conditions, sea-water temperature, day or night operation, experience of crew members, geographic location, number of search units, time delay in the alarm being raised, and condition of the man when falling.

Delayed Turn

The advantages of this optional alternative to the Williamson turn are that the man falling overboard is allowed to fall astern of the vessel, so clearing the propeller area. Turbulence in the vicinity of the man in the water is reduced by no sudden rudder movements, and the delay period, if used wisely, can become beneficial in a successful recovery (see Figure 6.8).

In this particular turn there is a very good case for releasing the second bridge lifebuoy. A line of direction is achieved for the vessel, as the ship returns either between the two buoys (the first being released at point A in Figure 6.8) or with the two buoys in transit.

The period of delay may vary according to the length of the vessel and the speed at which she was moving through the water, together with the perimeter of the turning circle. It is generally accepted that for most circumstances a delay period of approximately one minute would suit the majority of situations. The main disadvantage is that at some point in the turn the lookouts may lose sight of the man in the water.

Double Turn

This has the distinct advantage that the man in the water remains on the same side of the ship throughout the manoeuvre, so that job of lookouts to remain in visual contact is more likely to be successful. The turn begins when the helm is ordered hard over to the side on which the man fell once the alarm is raised, which will have the double effect of keeping the

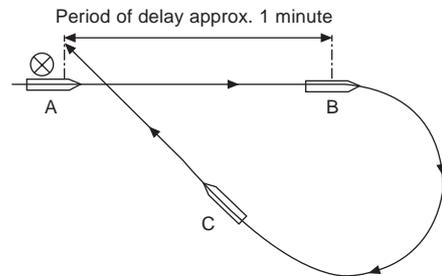


Figure 6.8 Delayed turn.

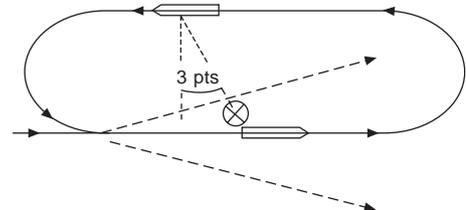


Figure 6.9 Double turn.

propeller clear of the main in the water, and bringing the vessel through 180° on to an opposite course. When the man is seen to be approximately 3 points abaft the beam, the vessel should complete the second, double, part of the turn in order to return to the position of the incident.

The approach to the man in the water should always be made to windward of him, so allowing the ship to drift down towards him. Recovery is achieved by boat or the use of scrambling nets down the ship's side and voluntary helpers wearing lifejackets with safety lines attached.

The success of the operation will depend on keeping the man in the water in sight, and if this is not possible because of fog or such other obstruction, the Williamson turn should be used.

HELICOPTER PROCEDURE

Any vessel which is to engage in helicopter operations should ensure that the crew are fully aware that the aircraft will need to overcome certain initial hazards. Any contact by the rotor blades of the aircraft with shrouds, stays masts etc. could cause the helicopter to crash on or around the vessel itself. In order to receive the aircraft in a safe manner, the deck should be prepared and the following actions taken well in advance of the helicopter's arrival on the scene.

1. Clear away any small gear from deck area together with any rubbish which might be lifted by the downdraught into the rotor or engine of the helicopter.
2. Lower all radio aerials between masts and in the vicinity of the reception area.
3. Clear the reception area of derricks and other lifting gear, and mark the operational point with a 'white' letter 'H'.
4. Provide a visual indication, by use of flags or smoke, of the direction of the wind. If smoke is to be used, then this should be used with discretion for a limited amount of time, so as not to interfere with



23. Westland/Sikorsky S61N helicopter civilian variant of the 'Sea King' engages in ship stores replenishment at sea.

the pilot's visibility. The international code pendant should be used if flags are to be the method of wind indication.

5. An emergency party should be standing by, with hoses connected with spray nozzles and foam extinguishers available.
6. Adequate lighting of the area must be used if the operation is to be carried out at night (Figure 6.10).
7. Communication must be established between the vessel and the helicopter crew.
8. The ship should be kept on a steady course, with the wind about 30° on the port bow. The speed of the ship should be adjusted to produce minimal movement of the vessel from her heading.

Landing and Evacuation of Personnel

1. All personnel should obey the instructions given by the helicopter crew when embarking or disembarking. There is a distinct danger of inadvertently walking into the tail rotor of the aircraft, which, especially at night, is sometimes difficult to see.
2. When engaged on hoist operations on no account must the winch wire be allowed to foul any part of the ship's rigging, and the end should not be secured in any manner whatsoever. Should the wire cable become caught in an obstruction, then the helicopter crew will cut the cable free.
3. No attempt should be made to handle the end of the hoist wire at deck level until any static electricity, which could have built up in the wire, has been discharged. Helicopters build up a charge of static electricity which could kill or cause severe injury, and pilots normally lower the cable into the sea before starting the operation, or let the cable touch the deck. Ship's personnel, when handling the cable after the static has been discharged, should wear rubber gloves, for the static could build up again during the operation. The static rod (hook) used throughout the operation should only be handled by one man (acting as the hook handler).
4. If the deck area cannot be adequately cleared, owing to permanent fittings, an alternative pick-up point could be established, e.g. a lifeboat towed astern.
5. Although emergency parties should be on standby, and fire-fighting gear on hand, hoses and loose gear could be drawn into the rotor by the downdraught. Essential equipment, therefore, should be ready for use but under cover to prevent accident.
6. Helicopters are limited in range and flight time, so that undue delay on site by personnel trying to save personal possessions could severely hamper the success of a rescue operation. In a distress situation transfers are restricted to personnel only.
7. When injured parties are to be transferred, helicopter crew men may descend to the ship's deck with or without a stretcher. Time may be saved by having the patient already in the Neil-Robertson type stretcher, which could then be lifted off directly or secured in the rigid frame stretcher of the aircraft.

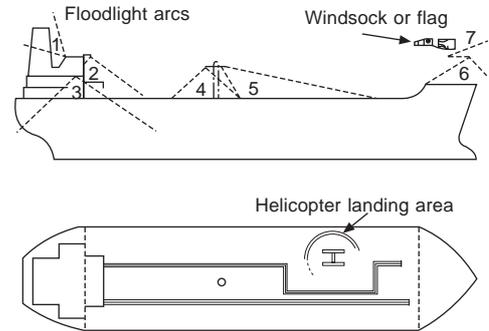


Figure 6.10 Deck lighting and landing areas for helicopters.

Extreme care should be taken not to direct floodlights into the helicopter cockpit, while providing maximum illumination to the operations area. The following lights should be available:

1. Floodlights illuminating funnel and high points.
2. Bridge front light illuminating after end of foredeck.
3. Overside illumination, to port and starboard.
4. Midships illumination, highlighting obstructions such as derrick posts etc.
5. Low direct floodlights over the operations area.
6. Floodlights illuminating danger areas and operations limits, forward.
7. Illumination of the wind direction indicator.

A flashing red light in the operations area will indicate to the pilot that the operation is curtailed, and the aircraft will immediately clear the area of the vessel.



24. Wessex Mk 5 of the Royal Air Force approaching a vehicle ferry prior to engagement.

8. In the majority of cases of personnel transfer a strop is used on the end of the cable to accommodate the body (Figure 6.11).

Type and Capacity

Table 6.1 lists the operating ranges, carrying capacity and the type of helicopter which may be encountered in marine operations. There are of course many other types of helicopter in use. The ranges and passenger

TABLE 6.1 Helicopters

<i>Type of helicopter</i>	<i>Range (nautical miles from base)</i>	<i>Passenger capacity</i>	<i>Remarks</i>
Wessex 60	150	16	Twin engine
Sikorsky S61N	195	26	Twin engine
Sea King	270	18	Used extensively around UK coast for SAR
Bolkow 105C	155	47	Unsuitable for winch operations except in an emergency

capacity given are only a guide. Factors influencing the range and number of persons carried will depend mainly on weather conditions, especially wind speed, and operational characteristics of the individual aircraft.

Communications

Some of the larger helicopters are fitted to transmit and receive on 2182 kHz MF. The majority are equipped with VHF/UHF RT, and cannot under normal circumstances work on the MF frequencies.

Should communications between ship and aircraft prove difficult, then a radio link via coastal radio station may be established or morse by Aldis Lamp flashed direct to the helicopter.

Operational Checklist

SAFETY CHECKLIST

For use with the ICS Guide to Helicopter/Ship Operations

To be checked by the officer in charge.

1. General

- (a) Have all loose objects within and adjacent to the operating area been secured or removed?
- (b) Have all aerials, standing or running gear above, and in the vicinity of, the operating area been lowered or secured?
- (c) Has the officer of the watch been consulted about the ship's readiness?
- (d) Are the fire pumps running and is there adequate water pressure on deck?
- (e) Are fire hoses ready? (Hoses should be near to, but clear of, the operating area.)
- (f) Are foam hoses, monitors and portable foam equipment ready?
- (g) Are foam equipment operators, of whom at least two are wearing the prescribed firemen's outfits, standing by?
- (h) Are the foam nozzles pointing away from the helicopter?
- (i) Has a rescue party, of whom at least two are wearing firemen's outfits, been detailed?
- (j) Is a man overboard rescue boat ready for immediate lowering?
- (k) Are the following items of equipment to hand?
 - (i) Portable fire extinguishers
 - (ii) Large axe
 - (iii) Crowbar
 - (iv) Wire cutters
 - (v) Red emergency signal/torch

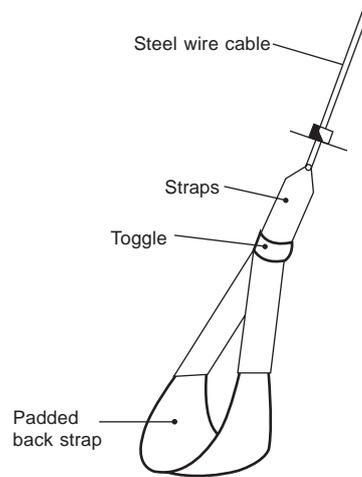
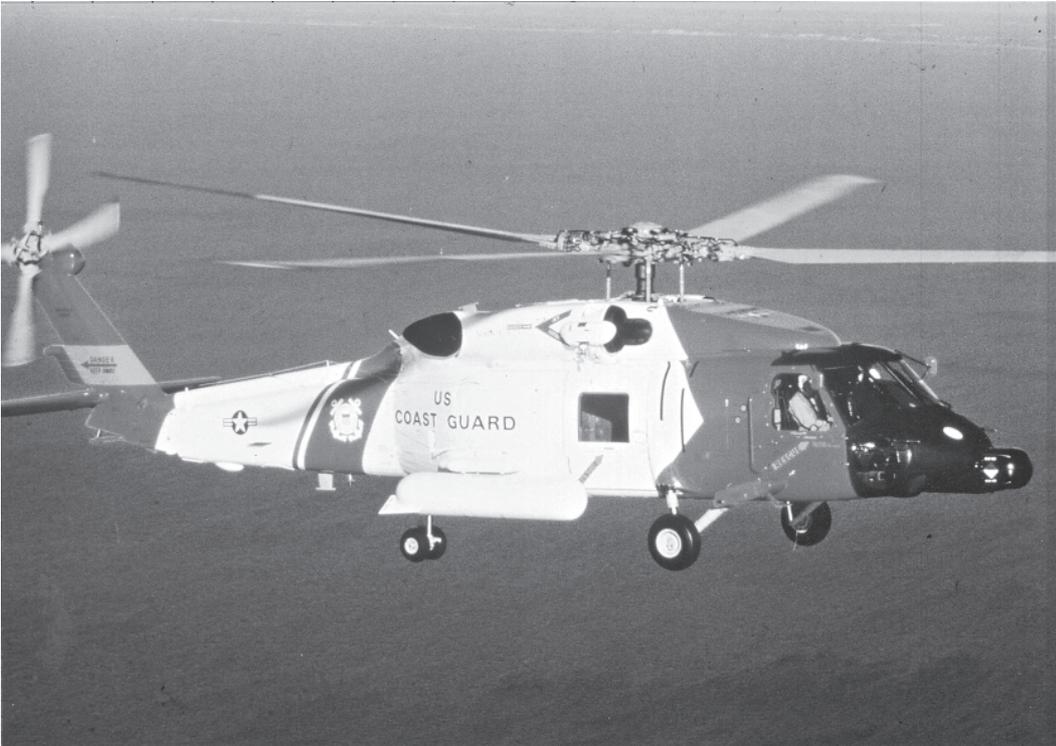


Figure 6.11 Helicopter lifting strop.

- (a) Take the strop and put both the head and the arms through the loop.
- (b) Secure the strop under the armpits, with the padded part positioned as high as possible across the back.
- (c) Tighten up the strop by pulling down the toggle as far as possible.
- (d) When secure inside the strop, extend one arm and give the thumbs-up sign to the winch man in the helicopter.
- (e) Put both arms down by the sides of the body.
- (f) On reaching the helicopter level do nothing until instructed by the helicopter crew.



25. Sikorsky HH-60J Jayhawk operated by the U.S. Coastguard, medium range recovery aircraft. Payload up to 8 survivors with 45 minutes endurance on scene.

- (vi) Marshalling batons (at night)
- (l) Has the correct lighting (including special navigation lights) been switched on prior to night operations?
- (m) Is the deck party ready, and are all passengers clear of the operating area?
- (n) Have hook handlers been equipped with strong rubber or suitable gloves and rubber soled shoes to avoid the danger of static discharge?

2. Landing On

- (a) Is the deck party aware that a landing is to be made?
- (b) Is the operating area free of heavy spray or seas on deck?
- (c) Have side rails and, where necessary, awnings stanchions and derricks been lowered or removed?
- (d) Where applicable, have portable pipes been removed and have the remaining open ends been blanked off?
- (e) Are rope messengers to hand for securing the helicopter if necessary? (Note: only the helicopter pilot may decide whether or not to secure the helicopter.)

3. Tankers

Before carrying out the above checks the officer in charge should check

that:

- (a) *For tankers without an inert gas system*
Tanks in, and adjacent to, the operating area have been vented to the atmosphere 30 minutes before the operation is due to start, thus releasing all gas pressure.
- (b) *For tankers with an inert gas system*
The cargo tank internal pressure has been reduced to a level which will ensure that there is no discharge of gas during the helicopter operation.
- (c) *For all tankers*
The tank openings have been re-secured after venting.

STEERING GEAR FAILURE OR LOSS OF RUDDER

The alternatives open to mariners who suffer the loss of steering facilities are limited to the type of vessel and the associated equipment which it happens to have on board at the time of the incident. In the case of a twin-screw vessel, steering is simple: by altering the revolutions on one or both engines a comparatively straight course can be maintained.

The old-fashioned method of rigging a jury rudder over the stern was a difficult proposition on conventional ships. On larger modern tonnage it could well prove impossible. To illustrate this problem, jury rudders were often constructed from conventional hatch slabs secured to a boom or derrick. Modern ships tend to be equipped with steel hatch covers, which, for obvious reasons, could not be used.

A much more practical method, which could be employed in an emergency, would be to stream drag weights over each side of the vessel. The type of weights employed would depend on the equipment carried by the vessel. For example, the majority of vessels are fitted with engine room 'bottom plates' which could well be used as improvised drag weights, acting like the trawl doors of a fishing boat. Such drag weights should preferably be flat and of substantial construction. Improvising materials normally carried aboard to suit an emergency situation will call for ingenuity and time if they are to be effective, but with thought most vessels will have some form of equipment that can be turned to good use for the occasion.

Problems may also arise not just in the rigging of such items but with their application, e.g. streaming astern. Many modern vessels, such as container or ore carriers, are not fitted with cranes or derricks, and the lack of these could make this method extremely difficult to operate. As an alternative option, a heavy weight streamed directly astern of the vessel, with steering wires led to each quarter, might prove a better proposition (Figure 6.12). The weight is heaved over to port or starboard to alter the ship's head as required. This weight could consist of any of the following: a heavy coil of natural-fibre mooring rope (this would become waterlogged and probably sink just below the surface), a roped and weighted canvas tarpaulin, weighted 50-gallon oil drums secured together, or a steel door or other similar steel plate fitted with floats on one edge.

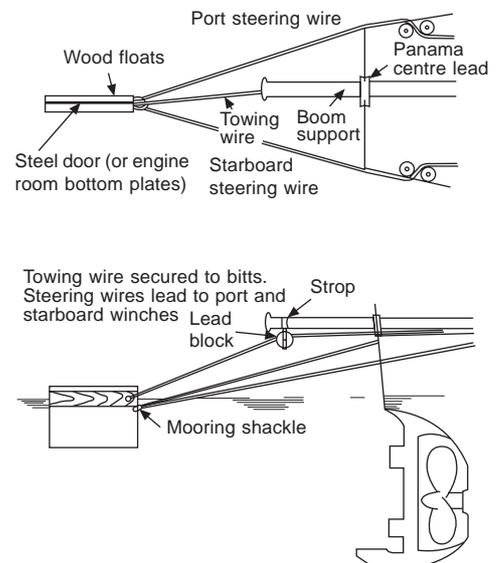


Figure 6.12 Improvisation in event of steering gear failure or loss of rudder.

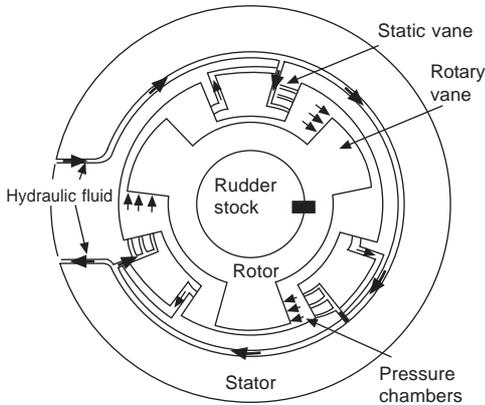


Figure 6.13 Rotary vane hydraulic steering.

With modern ship design, traditional methods of steering have been replaced by those employing a higher technology (Figures 6.13 and 6.14), and nowhere in modern seamanship is the difficulty of applying traditional methods to modern equipment better illustrated than in the case of steering gear breakdown.

Modern tonnage is usually built with the four-ram steering gear system, where the rams are operated by twin steering motors. The alternative two-ram system is rare, except in smaller vessels.

With a four-ram (electro-hydraulic) system, one steering motor activating two of the rams is considered to be the main steering for the ship. The second motor, linked to the remaining pair of rams, is considered the emergency steering gear. To illustrate the change in thinking from what was previously known as emergency steering, assume that the vessel is entering port, and that both motors are engaged for the approach pilotage and berthing. The reasoning behind this action is that, should the main steering gear fail, the second motor and second set of rams is already engaged. Again, if we consider a vessel at sea in open water. If the main

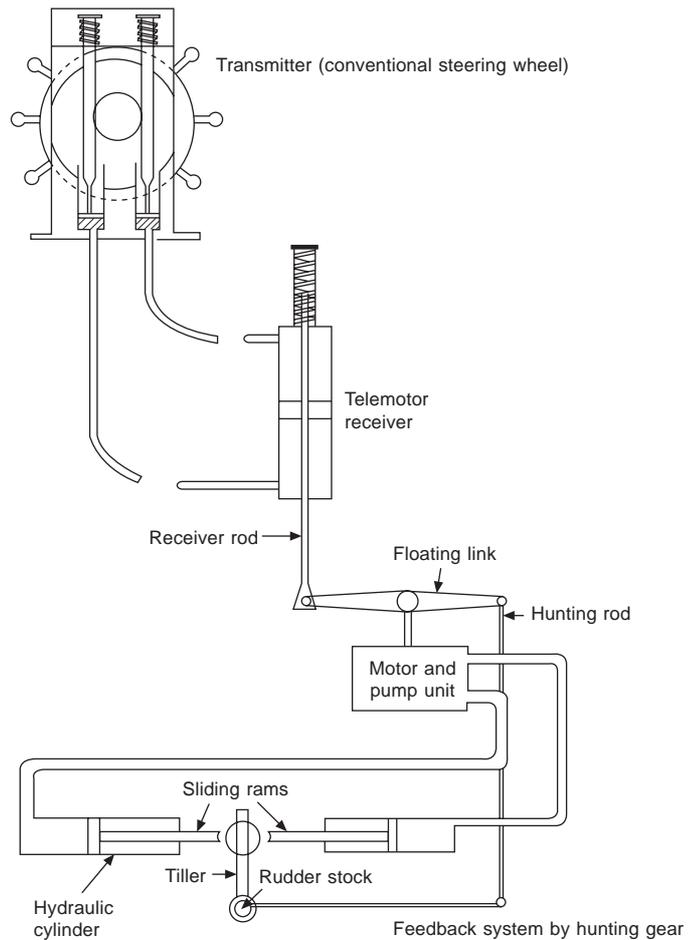


Figure 6.14 Telemotor transmission (two ram).

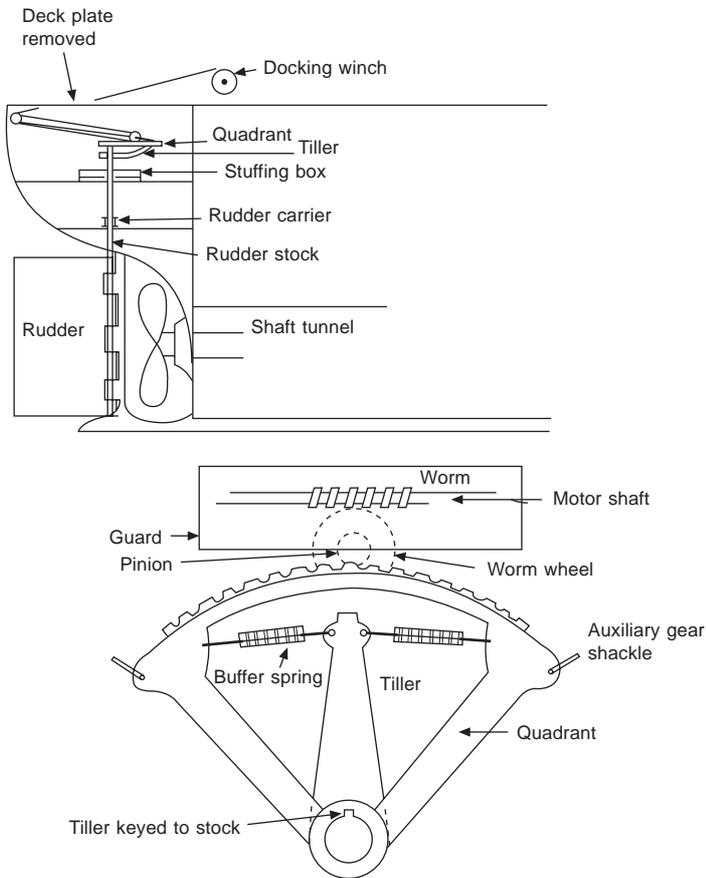


Figure 6.15 Alternative steering methods in event of breakdown.

motor fails and the main steering is lost, the first action of the officer of the watch would normally be to engage the second motor and the second set of rams to cope with the emergency.

Every vessel must also be equipped with some form of auxiliary steering gear, and some confusion exists over what constitutes auxiliary and what constitutes emergency steering gear. The auxiliary gear may be in the form of a very large steering wheel, geared directly to the rudder stock and operated manually. The method is tedious and hard work, especially over any considerable distance. Another method of auxiliary steering is one which employs heavy duty tackles shackled to the quadrant about the rudder stock, the downhauls from the tackles being led upwards through the weather deck on to the warping barrels of an aft docking winch (Figure 6.15). Probably the most popular method is one employed from the 'poop deck' using a linkage and dog-clutch arrangement which engages the steering rams direct, by-passing the telemotor system from the bridge.

SUBSUNK, PROCEDURE

British and many allied submarines are equipped with two indicator buoys for use in emergency. The buoys are situated fore and aft, and can be released from inside the boat, should the submarine find herself in difficulties and unable to surface.

The sighting of an indicator buoy may be the first indication that a submarine is in difficulties. No time should be lost in warning the authorities of the situation, the possible rescue of survivors being dependent on time not being wasted.

It is suggested that surface craft adopt the following procedure on sighting an indicator buoy:

- (a) Obtain own ship's position and advise by radio navy, coastguard or police authorities, providing full details of the sighting.
- (b) Do not stop engines but remain in the area.
- (c) Post lookouts to watch the indicator buoy and the surrounding area.
- (d) Operate echo-sounding machine. Periodically bang on the lower hull to indicate the presence of surface craft to the submarine.
- (e) Muster emergency boat's crew and have a boat made ready to recover possible survivors.
- (f) Advise the medical officer to be prepared to treat possible survivors for shock and exposure.

The bottomed submarine may try to communicate with surface craft by use of pyrotechnic floats, which burn with flame and/or smoke on reaching the surface and serve as additional markers. The exact position of the submarine is essential if a rescue is to be effected.

Depending on conditions in the submarine, survivors may attempt to ascend to the surface at any time after the accident has occurred. Relevant factors to their survival will be the depth of water at the scene of the incident and the facilities aboard surface craft, i.e. recompression chamber availability, medical facilities etc.

It is normal practice for survivors in this situation to wait before attempting to reach the surface, if conditions permit, until it is known that rescue craft are on the surface. The lack of air supply inside the submarine may of course make delays impossible.

Indicator Buoys

Subsunk indicator buoys are cylindrical in shape and made of aluminium. They are painted 'international orange' and carry a white light that flashes twice every second for a period of 60 hours. In addition, they are fitted with cat's eye reflectors and will have the following inscription:

FINDER INFORM NAVY, COASTGUARD, OR POLICE.
DO NOT SECURE TO OR TOUCH

Further written information will include:

‘Forward’ or ‘Aft’ and the code number of the submarine.

‘S.O.S. H.M. Submarine’ (if of British origin).

The buoy has 915 m of galvanised steel wire secured to its base via a stirrup. The wire has a fibre core (heart) and is 0.5 in (12 mm) in circumference, with a nominal breaking strain of 1000 lb (454 kg) (weight of the wire when in water 2 lb per 100 ft). It is feasible that the indicator buoy Type 0050 may still be secured to the submarine in up to 500 fathoms of water (1000 fathoms in the case of Types 0060 and 0070). See Figures 6.16 and 6.17 (produced from portions of *BA Notices to Mariners Annual Summary* with the sanction of the Controller, HMSO and of the Hydrographer of the Navy).

Additional reading: *Annual Summary of Notice to Mariners*.

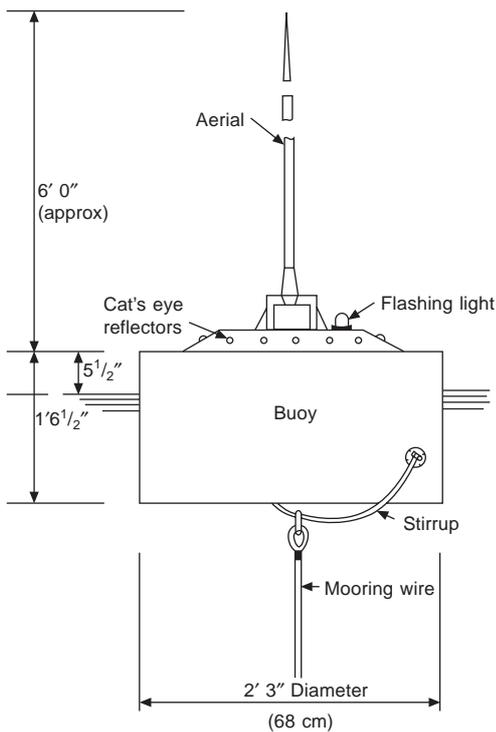


Figure 6.16 Type 0050.

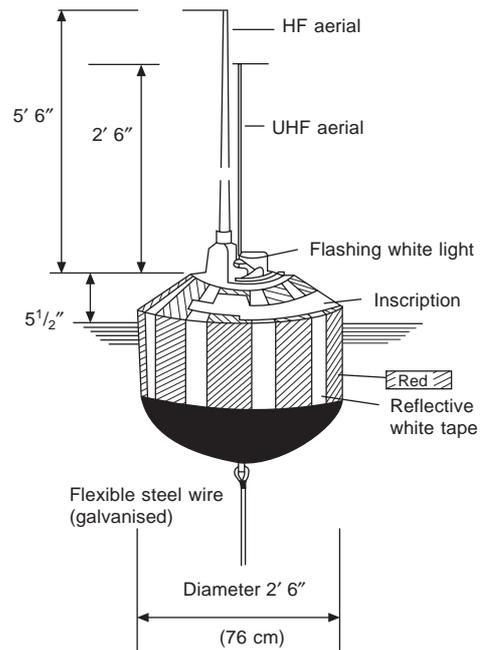


Figure 6.17 Type 0060 and 0070.

FIRE-FIGHTING



SMALL FIRES

The containment and subsequent extinguishing of small fires will depend on three main factors:

- (a) Location and type of fire.
- (b) Number and availability of extinguishing agents (see Table 7.1).
- (c) Quick thinking and training of fire-fighters.

Most modern vessels have an adequate supply of portable extinguishers to tackle any small fire immediately and, if not able to extinguish the fire, at least contain it. On discovery of a fire, personnel should raise the alarm, no matter what the size of the fire. This will allow back-up teams to equip themselves with more effective fire-fighting gear while containment of the fire is being attempted by the portable extinguishers.

These can be used to great effect when employed with common sense. The correct extinguisher for the job should be used, and probably the nearest extinguisher to the site of the fire will be the correct one. However, fire-fighters should check the colour and the labelled instructions on the outside of the extinguisher, since use of the wrong extinguisher could have fatal results for the operator. For example, a water extinguisher used on an electrical fire could cause severe burning and electric shock to the fire-fighter.

Think first and assess the situation, before taking action.

After raising the alarm, assess the type of fire and number of casualties, if any. Remove casualties if possible. Close down any ventilation. Obtain the nearest extinguisher considered correct for tackling that type of fire. Approach the seat of the fire close to the deck, allowing for the fact that heat rises. Have a standby man clear of the danger, ready to back up with further extinguishing agents. Emergency parties should be prepared to enter and relieve those first attempting to extinguish the blaze.

TABLE 7.1 Extinguishing agents

	<i>Electrical conductors</i>		<i>Non-electrical conductors</i>		<i>Non-conducting but toxic</i>
	Extinguishing by cooling		Extinguishing by smothering		
Types of fire (according to the combustible material)	1	2	3	4	5
Type A Dry fires (wood, paper, textiles etc.)	WATER Water/CO ₂ Water/Soda-acid Yes	FOAM Chemical foam Mech. foam Yes (not particularly advised)	POWDER Dry sand Dry chem. powder CO ₂ No (usable in special circumstances)	INERT GASES CO ₂ Steam No (usable in special circumstances)	VOLATILE LIQUIDS Carbon tetrachloride Methyl bromide etc. No (for use in small fires)
Type B Fire in combustible liquids	No (only spray)	Yes	Yes	Yes	Yes Use in closed space: WARNING: Only advisable in small fires, in well ventilated spaces or when the operator utilises it in free air.
Type C Fire in electrical equipment	No (only spray)	No	Yes	Yes	
Type D Fire in light metals	No (Risk of combustion and projection of incandescent particles)	No (Risk of combustion and projection of incandescent particles)	Yes (Special dry chem. powder for fires of this type)	No	No (Risk of combustion and projection of incandescent particles)
Type E Petroleum gas	No (only spray)	Yes	Ineffective due to pressure	Yes	Ineffective due to pressure
Type F Spontaneously combustible substances	Yes	Yes	Yes	As a temporary restraint	No

Subsequent Actions

Depending on the circumstances, cut off any power supply that may be live at the site of the fire. Rig hoses into the area to reduce the heat. Establish good communications as soon as possible. Prudent use of fire blanket, sand and scoop, wet towel or wet blanket can often prevent a major disaster occurring. Use the facilities available and make full use of improvised resources.

ACCOMMODATION FIRES AT SEA

Generally all major fires originate from either a smaller fire or an explosion. It is unlikely that fires within the accommodation will be caused by an explosion; consequently, speedy and efficient action to deal with the smaller fire will often prevent the larger, more crippling fire developing.

Regular training drills, well planned and using all the ship's equipment, are not only reassuring to passengers and crew members but an efficient method of making personnel familiar with the equipment available. Even if a fire is only suspected, the alarm should be raised immediately and crew members should be in no doubt that a false alarm would not result in punishment.

Accommodation fires generally occur in Class 'A' combustible material (see Table 7.1); bearing this in mind, the following course of action is recommended:

1. Raise the alarm.
2. Reduce speed.
3. Close down all mechanical ventilation.
4. Have fire-fighters, working in pairs, investigate and tackle the fire.
5. Isolate electrical 'live' circuits.
6. Surround the fire, attacking it from as many sides as possible with hoses.
7. Close all fire and watertight doors.
8. Approach the fire with the aid of breathing apparatus.
9. Have communications officer standing by to transmit emergency or distress signals.
10. If traffic and the weather will allow, bring the wind to a direction that will minimise the spread of the fire, e.g. if the fire is forward, bring the wind on to the quarter, and if the fire is aft, bring the wind ahead.

} (all types of fire)

The order of events will, without doubt, vary with circumstances, and the actions of individuals will be dependent on the location of the fire and the facilities available in the vicinity. The above-mentioned procedure may be elaborated on.

Reduction of speed is necessary because the speed of the vessel through the water will provide continuous draught for the fire. This will provide food for the fire, not the required starvation.

Closing down all mechanical ventilation will help to stop the passage of heat and smoke throughout the ship. Should heat or smoke be drawn in

through passages etc. it may become necessary to evacuate adjoining compartments. Again starvation of the oxygen supply, effectively reducing the spread of heat smoke and the fire itself, will not be accomplished.

Fire-fighters need to operate in teams of not less than two men because the average person's courage in the face of danger is reduced considerably if he is alone. Two or more men may also be necessary to achieve a success, or at least better efficiency than one.

Isolation of 'live circuits' is necessary because the dangers of water as an electrical conductor are well known, particularly when a strong jet of water is being brought into operation. Isolation of live circuits must be carried out before the fire is attacked with any water branch line, whether operating on jet or spray.

Surrounding the fire and attacking it, rather than operating from one side only, stops the fire being pushed from one region to another. It should not be forgotten that any fire has no less than six sides, and all six sides should be attacked whenever possible. This may only be in the form of boundary cooling of bulkheads, but the heat content and its effect are reduced.

Watertight and fire doors must be closed for any emergency when the hull is threatened. Not only is the passage of heat and smoke restricted but subsequent casualties caused by the passage of fire or explosion can be greatly reduced. This is especially important on passenger vessels.

Breathing apparatus is essential for tackling accommodation fires, especially if internal fittings such as furniture containing polyurethane foam are present. Toxic fumes from burning upholstery can be extremely hazardous for fire-fighters. Smoke helmets, for this reason, should not be worn, only the self-contained breathing apparatus.

Tackling the fire speedily is essential. Unless early location of the fire is made, fire fighting may become extremely difficult. Rows of cabins and passageways tend to transmit heat and smoke quickly over a considerable area. Many of the cabins may form smoke traps, disguising the location of the fire to the fire-fighter or rescuer.

Initial actions are important, and these will depend on location and type of fire. If it is in a cabin, considerable build-up of heat may have already taken place, and entry could be disastrous if the interior has not been cooled off. This can usually be achieved by breaking open the bottom panel of the door and directing a jet to the deck head. Indiscriminate smashing of ports and doors, however, should be avoided unless necessary to save life.

GALLEY FIRES AT SEA

The successful extinguishing of a galley fire will be more readily achieved if the location and method of using the available extinguishing agents are known before hand. Freedom of access to these extinguishing agents is essential, and they should at no time be used for any other purpose than that for which they are designed.

A ship's galley will normally be equipped with several or all of the following extinguishing agents;

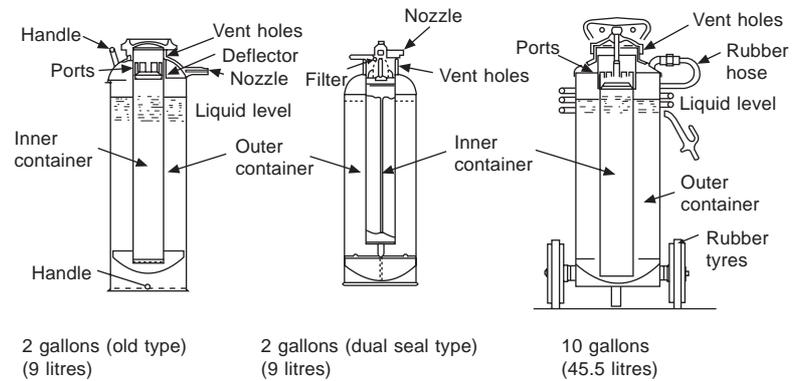


Figure 7.1 Sectional views of foam fire extinguishers.

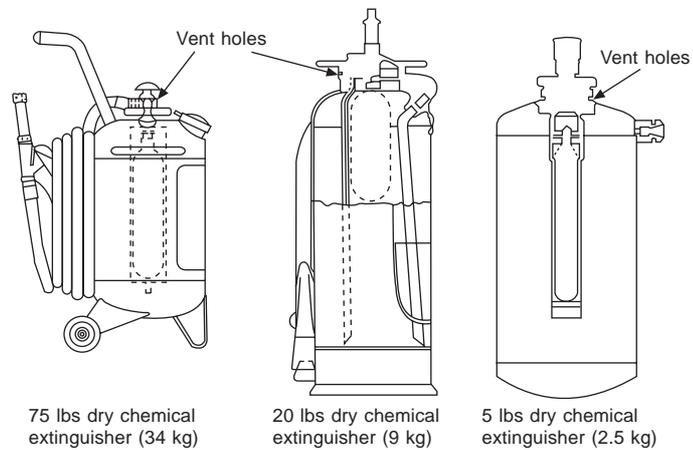


Figure 7.2 Chemical extinguishers.

1. Foam extinguishers for oil-fired stoves (Figure 7.1).
2. Dry powder extinguishers for electric stoves (Figure 7.2).
3. CO₂ extinguishers.
4. Fire blanket.
5. Sand and scoop in buckets or containers.
6. Small hose reel and nozzle.
7. Fire box, close to hand, containing hose, spray/jet nozzle, and fire axe.

Speedy and correct use of the above could reduce the risk of a major fire. Lack of thought in tackling the common chip pan fire could result in the whole of the galley area becoming engulfed in flames, with the subsequent risk to catering personnel and to fire-fighters tackling the blaze. The majority of galley fires occur at the cooking stove, or from activities associated with the stove, e.g. lighting oil stoves, smoking when refilling oil reservoir, overheating pans of foodstuffs, especially fats etc.

Human error is probably one of the main contributing factors when pans of fat and such like are left unattended, the escalation into a major blaze occurring when water is used as an extinguishing agent. A limited amount of forethought and training may prevent a serious outbreak by

covering the open pan with a damp cloth, so cutting off oxygen from the blaze.

The destruction of the so-called fire triangle (Figure 7.3) can be readily achieved in all small fires by the elimination of heat, fuel or oxygen. Major fires will respond in a similar manner when one of the three is nullified, but it may take considerably longer than with a minor outbreak. For instance, an oil drip tray turned into a blazing inferno by the direction of a jet of water on to it within the confines of the galley, is almost impossible to control whereas oxygen could easily have been excluded by deflecting foam onto its surface.

A clean, well disciplined galley area will reduce the risk of fire. Regular drills and the training of crews, especially catering personnel, in correct fire-fighting procedure will reduce the risk still further.

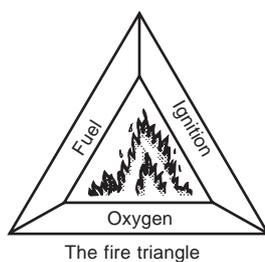
MACHINERY SPACE FIRES AT SEA

The engine room of any vessel must be considered an extremely high risk area, containing as it does certain items more susceptible to fire than any others on the ship. The majority of fires within the engine room are oil fires, Class 'B' or electrical fires, Class 'C' (see Table 7.1).

When an assessment of an outbreak of fire within the machinery space is made, detail as to the type and the extent, together with the location, must be thorough. A minor oil spillage will probably be a localised outbreak capable of being tackled by portable equipment, whereas a larger oil leak, say from a broken fuel pipe, may cause an extensive fire that can only be extinguished by use of a fixed smothering system such as steam smothering, CO₂, Halon or foam.

Once an outbreak of fire inside the engine room has been discovered, a suggested course of action would be as follows:

1. Raise the alarm, or order somebody else to raise the alarm.
2. Inform the bridge at the earliest opportunity.



All three elements of the fire triangle are needed to support combustion. The elimination of any one, prevents fire.

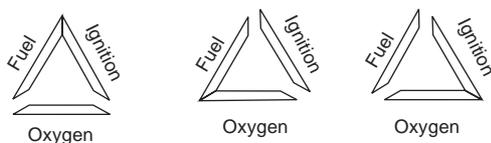


Figure 7.3 Making and breaking of fire triangle.

3. Investigate and tackle the fire immediately, if practicable.
4. Continue to fight the fire until emergency party arrives at the scene.
5. Rescue injured persons as soon as practicable.
6. Establish supply of equipment – foam compound etc.
7. Establish communication system, to include the bridge.
8. Attempt to contain the fire and extinguish by conventional means before use of fixed smothering apparatus.
9. Close down all ventilation, using non-essential personnel, once the alarm is raised and the location of the fire is established.
10. Close all watertight and fire doors as soon as possible after the alarm is raised.

The order of events will vary with circumstances, of course, and the recommendations given above must be used only as a guide. The actions taken by the Master, chief engineer, engineering officers etc. will also be dependent on the type of machinery and the geography of the engine room; but any machinery space fire should be tackled after investigation has shown that the approach adopted will contain and possibly extinguish the outbreak. Conventional means of fighting the fire should be continued until supplies of foam compound are consumed or the available breathing air bottle supply runs out. Then, as a last resort, CO₂ or the equivalent should be injected in accordance with the fire-fighting plans of the vessel.

The actions needed to extinguish an engine room fire should be taken, bearing in mind the limited supplies of conventional fire-fighting equipment on board. At the outset it should be assumed that a time will arrive when conventional fire-fighting methods can no longer be applied. To ensure the minimum amount of delay, therefore, any fixed fire-fighting installation should be made ready for operation at the earliest possible moment after the extent of the fire has been assessed.

Rescue of casualties should be a matter of priority, with due regard to the safety of rescuing personnel. Correct methods of gaining access to a fired area must be employed to prevent the fire spreading. Breathing apparatus should be employed to reduce the possibility of further casualties. First aid parties should be ready to treat any injury, especially burns. Regular drills will ensure that personnel when attached to an emergency or stretcher party know how to recognise burns and apply burn dressings.

Use of the breathing apparatus and stretchers within the confines of a compact engine room is not easy, and crew members should be exercised whenever drills are called to perform demanding tasks throughout the awkward parts of the vessel. The length of a contact line between any two fire-fighters should be tried and tested for adequacy when they are using engine room ladders. Crews should be trained to use a messenger-location guide line when advancing into smoke-filled blind areas, bearing in mind that if the fire is deep-seated, say around the bottom plates, some breathing bottles will only last about 20 minutes.

Establishing efficient communications is one of the most essential requirements of tackling a fire at sea. There must be a link up from fire-fighters to the support personnel and to the bridge. In order for decisions

to be taken, people in authority must be kept fully informed at all times of the situation. The time to withdraw and inject, say CO₂, can only be made by someone who is aware of all the facts, especially those regarding supplies of equipment, condition of personnel, location of fire, and danger of explosion.

Containment of the fire should first be attempted by use of conventional means, and the possibility of using a water spray from above the fire, as with a funnel fiddley construction, must be seriously considered. Not only will this produce a cooling effect before the injection, say, of CO₂ but also a steam cloud, causing a blanketing effect over the fire.

Watertight and fire doors should be closed as soon as possible for the safety of the vessel. Engine room personnel should be well aware of emergency and tunnel escape systems.

Summary

On the discovery of the fire, the alarm must be raised, casualties removed from the scene and the fire investigated and tackled with primary equipment. Depending on weather conditions and the location of the fire, the oil supply should be cut off, emergency parties sent to the scene, and boundary cooling should be started with the aid of emergency pumps and emergency generator.

Communications should be established to include the Master. Control of the vessel should be adjusted to minimise draught for as long as main engine power remains available. Any fixed extinguishing system should be made ready for immediate use, the communications officer told to stand by, in the event of urgency or distress messages becoming necessary for transmission.

Ventilation, fire doors and watertight doors should be sealed, and overhead cooling of the fire scene should be carried out if possible. Personnel should be aware of particular hazards regarding smoke density in an already dark area, and the possibility of re-ignition from hot metal surfaces after they have assumed the fire to be out.

Preventive Measures

The strategic siting of portable extinguishers, drip trays, hose boxes and hydrants can greatly reduce the risks of major fires developing. Regular testing drills of crew and equipment in unfamiliar surroundings and extensive precautions against accidental spillage will also go a long way towards preventing machinery space fires.

CARGO SPACE FIRES AT SEA AND IN PORT

Fires in cargo spaces can generally be separated into two categories: (1) in dry cargo vessels with dry bulk cargoes or general cargo, and (2) in bulk oil, chemical or gas carriers. The methods of extinguishing fires will be dependent on the nature of the burning cargo and the other parcels of cargo around it, together with the location of the fire in relation to such features as engine rooms, pump room, paint lockers etc. Often water directed on to the seat of the fire appears the most effective action, but this method of extinguishing should not be accepted without question, since the stability factors of the vessel have to be considered. Fixed gas or steam smothering systems can also be employed as alternative options.

The following general approach is recommended:

1. Raise the alarm and inform the Master of the vessel.
2. Order the engine room to immediate 'Stand By' and reduce the vessel's speed.
3. Close down all ventilation to the fire area.
4. Assess the situation with regard to possible casualties and refer to the cargo plan to establish the type of cargo on fire.
5. Order Communications Officer to stand by.
6. Commence boundary cooling and check adjacent compartments for additional fire risks.
7. Inject fixed CO₂ or other fire fighting medium as per ship's fire plans.
8. Investigate port of refuge facility, and inform shore authorities.

NB. The risk of opening up a battened down compartment, when at sea must be considerable. To inspect the compartment would allow air to enter and feed the fire, with the possible flash-back situation occurring.

If the vessel were in a port, with extensive back-up facilities available the method of approach would probably be different. Harbour authorities would have been informed and non-essential personnel could be disembarked to a place of safety.

A direct inspection and attack on the fire could be made by a full fire-fighting team with the view to digging out the seat of the fire possibly.

If the fire were found to be situated in, say, a 'tween deck rather than a lower hold, conventional methods of tackling the situation would be a prime consideration. However, hose branch lines should be pressurised and in plentiful supply before anyone entered the space. Breathing apparatus should be donned and ready for immediate use, with men wearing protective clothing. Emergency lighting should be on hand, with reserve personnel. Bilge pumps should be in operation.

General advice for the conventional tackling of cargo space fires cannot be given in any direct form. Methods of approach will depend on the circumstances of the case. However, any seafarer who is trying to advance on a fire virtually blind should be aware of the following points:

- (a) Never go into the compartment alone.
- (b) Wear breathing apparatus when entering.
- (c) Ensure that communications are established when entering the compartment.
- (d) Shuffle only, do not walk. Keep body weight on the heel of one foot, using the other foot to detect forward objects.
- (e) Keep the back of the hand in front of the face while advancing.
- (f) Advance behind a spray curtain towards heated areas.
- (g) Reduce damage by manually directing jets of water towards the fire area.
- (h) Bear in mind that water is only effective when it is being turned to steam.
- (i) When approaching the fire work low down, reducing the smoke and rising heat effect.
- (j) Remember that, at the fire point, the first jets striking the burning material will cause an expansion of surrounding gases. This will produce large volumes of steam and smoke at first, but this will soon clear and conditions improve.
- (k) Keep regular checks on the fire containment, by feeling the heat content and checking temperatures at different levels on adjacent bulkheads. Spray branch lines can be most effective in boundary cooling to reduce temperatures, and their use lessens the risk of distortion of steel plate while covering a larger area than a jet.

Bulk Oil, Chemical or Gas Carriers

Fires on board these vessels are generally started by or associated with explosions. Conventional fire-fighting methods may be of little use other than providing a delaying action in order to carry out a successful abandoning of the vessel.

This is by no means a defeatist attitude. The main concern must be for the safety of life, and, to this end, if the use of hoses can provide valuable time to launch survival craft, then they have performed the most essential of functions. When used with spray nozzles, they can cool large areas of plate and perhaps stop the fire from spreading to accommodation areas. Foam appliances may also be used to prevent burning oil from reaching the accommodation decks.

With oil, chemical or liquefied gas cargoes, the development of toxic vapours is a distinct possibility. It is essential, therefore, that emergency action parties wear breathing apparatus and protective clothing. Where oil is known to be burning, the generation of dense black smoke will make fire-fighting extremely hazardous, and considerable thought must be given to the amount of oil, type of oil, surrounding cargoes, and access to the seat of the fire, before committing fire-fighters.

Efficient communications must be established, as with all fire situations, but walkie-talkie radios should be used with extreme caution in areas of explosive vapours unless they are of a safe type. Established communications between fire-fighters and the bridge could well assist the localising and containment of the fire; the Master may turn the vessel stern to the

wind, with the idea of reducing the draught within the vessel or even blowing the fire overside. The ship's head may need changing at a later stage in order to provide a lee for launching survival craft. These manoeuvres depend, of course, on the availability of main engine power and unimpaired steering gear.

Dust Explosions

With certain types of cargo where a heavy dust content is a prominent feature it is not uncommon to encounter large explosions and the creation of fireballs. These generally occur when attempts to extinguish a small fire by means of hose jets causes a massive disturbance of accumulated dust particles. The dust disturbed by the action of the hose is often thrown upwards and attempts to resettle above the fire area. The dust particles are so small that ignition can take place quickly while the dust cloud is still attempting to resettle. The whole dust area ignites, together with the oxygen content of the atmosphere, creating a fireball or explosion over an area depending on the amount of dust disturbed and the heat generated.

Typical cargoes susceptible to dust explosion are grain type cargoes, e.g. barley, wheat etc. Should the size of the compartment be restricted, then a dust explosion could engulf the whole area and the hot gases could blow out the side of the vessel. The explosion would be violent and sudden, and if any fire-fighters were inside the compartment operating the hoses, they would suffer severe burns at the very least.

The cause of a dust explosion gives the answer to their prevention. Hose jets should not be used until the area has been thoroughly damped down by spray nozzle action. The dust will then congeal rather than remain in fine particle form.

Vessels carrying bulk cargoes such as grain, coal etc. should take extra precautions in the event of fire to ensure that, if possible, the fire is contained at an early stage. However, fire-fighters should realise that at the bottom of empty or partially filled cargo holds dust tends to accumulate, and the risk of dust explosion at the bottom of a hold is far greater than at the top of any cargo.

Deep Tanks

General cargo is often carried in deep tanks. Should a fire develop either at sea or in port, deep tanks lend themselves to immediate flooding as a means of resolving the problem.

Counter-filling of opposing ballast tanks allows the fire to be extinguished without the stability of the vessel being in any way impaired. However, this method would produce a limited amount of free surface during the process of filling and pressing up the tank.

The tank could be flooded from the engine room pipeline system, by hose down the air pipe, or by hose via the manhole into the tank, if accessible. Bilge pumps should have been checked and the cleanliness of hat boxes established before loading cargo, to ensure that the water could be pumped out after the fire was extinguished.

Summary

On the discovery of the fire, raise the alarm and attempt to identify the source and location of the burning material. Emergency parties should close down ventilation and check adjacent compartments. Hoses should be run out and boundary cooling started while stability factors are checked. Establish a communications link and supply lines after assessing the nature of the fire and method of extinguishing to be employed.

Check the cargo plan and identify potential hazards within the compartment. As a general rule, prepare fire-fighters for 'tween deck and/or lower hold entry, depending on the fire's location. Prepare fixed smothering or extinguishing systems with the idea of inerting the space *except* for nitrate or sulphate cargoes. Steam smothering must never be used when explosives are present. Should nitrates, sulphates or explosives comprise the cargo, then flooding the compartment may be the only answer, together with the associated actions to maintain stability.

Preventive Measures

Prevent smoking during the loading or discharging of cargoes. Check on cargo ventilation requirements and liability to spontaneous combustion. Check out incompatible cargoes, and their respective stowage areas.

PAINT ROOM FIRES

The problems concerning fires in paint rooms and other similar stores are usually related to one or more of the following:

- (a) The location of the store, often well forward in the fo'c'sle area.
- (b) The size of the store, which is often quite small, limiting access and internal movement.
- (c) The high risk of explosion, the possibility of excessive heat build-up and the risk of toxic overpowering fumes from the contents of the store.

Many fires in stores of this nature are caused by a combination of human error and spontaneous combustion. It is always so easy after a day's painting to clean off with a paraffin wad and throw it into a damp/wet corner. Spontaneous combustion action taking place several hours later may cause a minor flame that grows very quickly into a major fire.

Tackling the fire will be hampered by the plentiful supply of oxygen in the area, especially if the store is sited well forward. A fast heat build-up in a confined space can be expected, limiting the ability of fire-fighters to reach the seat of the fire. Breathing apparatus will be required to get in close, and the danger of chemical reaction with water as an extinguishing agent will be ever-present.

Boundary cooling of other bulkheads, deckheads and decks must be of prime consideration, together with the removal of stores adjacent to the fire area. Spray nozzles will probably be used to provide a heat shield for fire-fighters approaching the blaze. The best approach is at low deck level, with the intention of directing a hose jet at the deckhead to effect a cooling reaction within the store.

NB. Most paint rooms are now protected by a sprinkler water protection system.

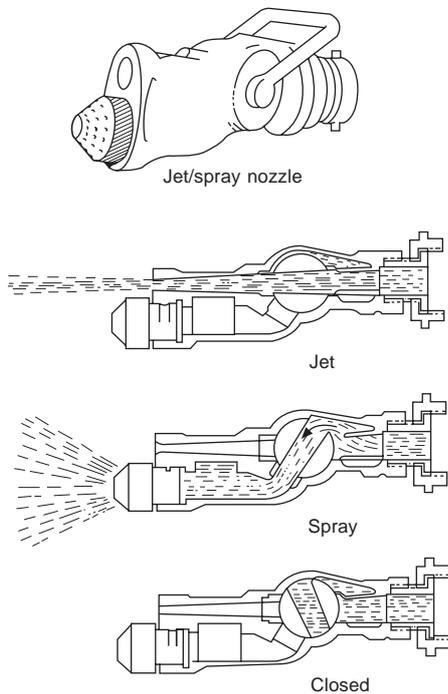


Figure 7.4 Operation of combined jet/spray nozzle.

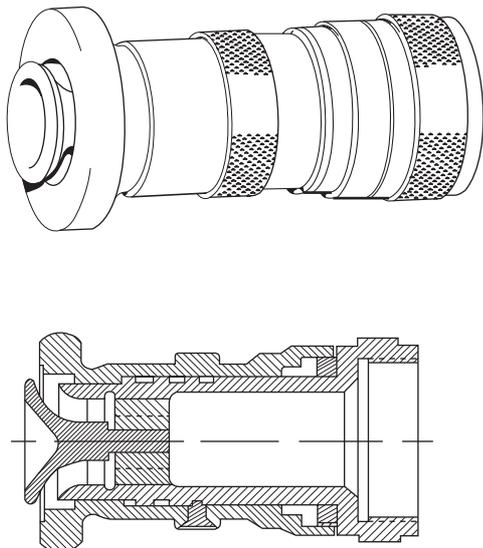


Figure 7.5 Section through jet/spray nozzle.

Without doubt a carefully chosen course and the reduction of wind effect within the confines of the ship will greatly assist in fighting the fire. Good communications established as soon as possible between bridge, engine room, and the site of the fire must be considered essential, preferably by walkie-talkie. Speedy action with regard to the gathering of equipment, water on deck etc. is also essential to the effectual control of the fire. Use of a foam-based portable extinguisher in the early stages on material with an oil content could damp down a major outbreak until additional fire-fighting systems become available.

Casualties should be expected, probably people overcome by smoke, heat or toxic fumes, or a combination of all three. The main danger is the spread of the fire into the forward cargo holds. The method of tackling this should be one of direct attack.

FIXED FIRE-FIGHTING INSTALLATIONS

1. Steam smothering system.
2. CO₂ gas system.
3. Halon gas system.
4. Foam deck system.
5. Pressured water sprinkler system.

When vessels in the part caught fire while at sea, they usually tried to fight the fire by conventional means. Obviously each case must be treated in the light of the circumstances prevailing at the time, with due consideration being given to the facilities available. In the author's view attempts should be made in the case of engine room fires to bring them under control before the injection of a fire-fighting gas medium, for the following reasons:

1. Injection of, say, CO₂ gas would immobilise the machinery space and virtually leave the vessel without motive power and at the mercy of the weather.
2. Once injection has taken place, it is unlikely that a second supply of gas could be made available. Therefore, as there is only one chance in most cases for the gas to take effect, this chance should not be wasted in the early stages. This is not to say that there should be any hesitation once it has been decided to use gas. Then speedy injection could be to the benefit of all.

Conventional fire-fighting methods in the way of hose/branch lines and foam installations within the machinery space may be the ideal fire-fighting medium. Breathing apparatus will be needed, so that a plentiful supply of 'full air bottles' will be required; failing this, means of refilling (compressor) air bottles, located outside the machinery space, should be provided. In several cases valuable time has been bought by fighting a fire by conventional means until the air bottles for the self-contained breathing apparatus have run out. Time won in this way can be usefully employed in seeking out a safe anchorage or port having good fire-fighting facilities or clearing away survival craft.

Cargo hold and tank space fires may, by their very nature, have to be treated as completely different sorts of fire. Relevant facts as to the

available access to the fire area have to be considered, and flooding of a fire area may also be a worthwhile proposition, having due regard to the stability and free surface effects.

Steam Smothering

This is a fixed system of steam injection into such compartments as cargo holds and 'tween decks, machinery spaces and tank areas. The steam is delivered from the main boilers of the vessel via a 4 in. (10.16 cm) or 6 in. (15.24 cm) pipeline to several junction boxes usually situated on the weather deck. These junction boxes are accessible and service numerous 2 in. (5.08 cm) branch lines into protected spaces. Each branch line is fitted with a local valve operated separately from inside the box.

The steam inlet pipes are situated at the lower levels of the compartments. Steam, being lighter than air, will have the tendency to move upwards to occupy the upper volume of the space, so that a low-seated fire will be more difficult to extinguish than, say, one at a 'tween deck level. Should the fire be situated at tank top level, then the steam injection will, more than likely, have to be continued for some considerable time.

It is important at the time of discovery of the fire to batten down the space, not only to deny oxygen to the fire but to contain the steam once injected. Considerable condensation will occur with the steam injection. This is liable to spoil goods that are subject to water damage, but this disadvantage must be weighed against possible loss of the ship. Such cargoes as newsprint, woodpulp, and grain can be expected to suffer considerable damage in the moist conditions through swelling.

Hold preparation must be considered when a vessel is equipped with a steam smothering system, especially when she is engaged to carry bulk cargoes. The steam inlet or injection pipes into the compartment must be covered in burlap or other similar material which will allow the passage of steam but prevent the pipes becoming blocked by the cargo.

Boundary cooling should take place in and around adjacent compartments. Double bottom tanks, if used for fresh water or water ballast, should be pressed up under the seat of any fire.

Any oil in adjacent double tanks should not be transferred. The transferring of oil out of the tank would only leave the space full of gas, adding to the danger of the situation. Action by the individual on oil double bottoms would depend on the type of oil and possible access to the tank top area for the purpose of cooling.

Once steam has been injected the compartment should be left in the battened down condition until it is thoroughly cooled down. No attempt should be made at an internal inspection until external temperatures indicate that it is safe to do so. Re-ignition has often occurred in the past because of impatience to inspect after a fire.

Carbon Dioxide (CO₂)

This is probably the most popular of all the fixed fire-fighting systems employed at sea. The normal design incorporates a fixed bank of CO₂ container bottles whose contents can be directed, automatically or by direct manual operation, into any of the ship's protected spaces (Figures

7.6 and 7.7). Many systems are used in conjunction with a smoke detector unit, the same sampling pipes guarding against smoke being used to inject the CO₂ gas via a three-way valve.

Fire-fighters should be aware that CO₂ is a smothering agent rather than an actual extinguishing one. The purpose of the gas is to deprive the fire of oxygen and by so doing break the fire triangle. Carbon dioxide is heavier than air and is usually injected into the upper levels of cargo holds and machinery spaces, all the oxygen being pushed to the upper levels as the CO₂ settles at the bottom of the space.

CO₂ gas has the following characteristics:

1. It is a non-flammable gas.
2. It is colourless.
3. It is odourless.
4. It is readily available in almost every port of the world.
5. It is comparatively cheap compared, say, to Halon.
6. Systems may incorporate smoke detector units.
7. It may be kept either in 45 kg cylinders or in bulk storage tanks.
8. Normal temperature of liquefied CO₂ is -20°C .

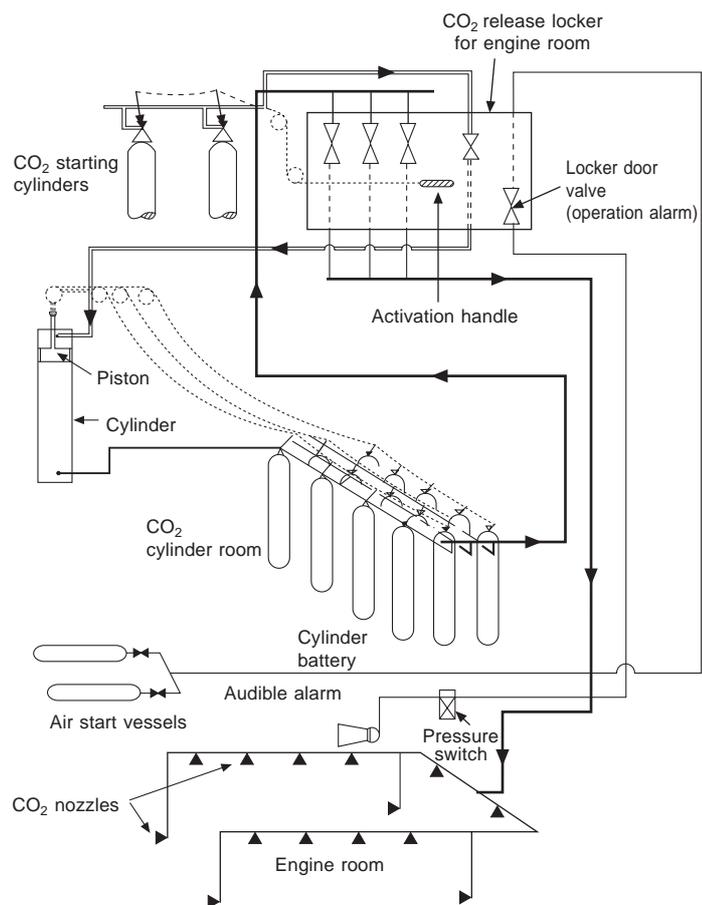


Figure 7.6 CO₂ total flooding system for engine room.

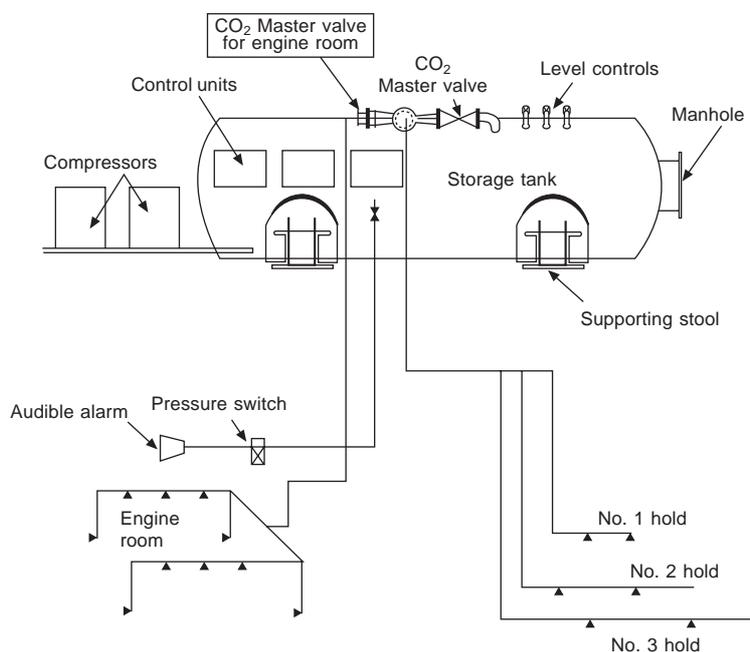


Figure 7.7 CO₂ total flooding system.

The storage tank, which is designed to hold in excess of 10 tonnes of liquefied CO₂, is mounted on supporting stools, insulated by 150 mm of fire-resistant polyurethane foam, and finished in 1 mm galvanised steel plates. Refrigeration units may be attached to the tank or sited separately, giving the CO₂ a normal temperature of -20°C. Two independent units are the norm, working automatically, each being cooled by sea water and operated from external control panels. Alarm systems for each tank cover compressor failure, high pressure inside tank, low level in the tank and leakage through safety valves.

Halon

The chemical name for halon is bromotrifluoromethane (CF₃Br), and it is also known as BTM or BCF. It has the following characteristics:

- | | |
|-------------------------------------|---------------------------|
| 1. Boiling point at 1 bar | -57.8°C. |
| 2. Freezing point | -168°C. |
| 3. Critical temperature | 67°C. |
| 4. Critical pressure | 39.64 bar. |
| 5. Critical density | 745 kg/m ³ . |
| 6. Density in liquid state at 20°C | 1.574 kg/m ³ . |
| 7. Density in gaseous state at 20°C | 115.6 kg/m ³ . |

Halon 1301 is colourless and odourless, non-corrosive in its gaseous state but highly corrosive when dissolved in water. It may be considered as an inhibiting agent rather than an extinguishing agent, as it breaks down the chain reaction which keeps a fire burning. The method by which halon gas succeeds in inhibiting fire is not yet thoroughly known.

Probably the most attractive feature of halon gas 1301 is the fact that it is the least toxic of all the gas variants used for extinguishing fires available on the market to date. Recent tests have shown that undercomposed halon 1301 (natural halon gas) after being inhaled by humans had effects lasting up to 5 minutes from a concentration of 7 per cent. Tests carried out assumed no damage to the subjects' nervous systems. It should, however, be borne in mind that any person who is suffering from abnormal mental strain may have a high adrenalin concentration, and the mixture of adrenalin and halon 1301 results in a temporary disturbance of heart activity.

Generally speaking, it is safe for humans to inhale the gas for a period of about 5 minutes. In small concentrations a distinctive acrid smell from the hydrogen bromide and hydrogen fluoride will have an irritating effect, though this could be considered a useful warning system to fire-fighters, as the margin of time from the moment of irritation to the moment that the absorbed level is considered dangerous is short. Hazards to personnel from poisonous smoke, heat, carbon monoxide the lack of oxygen in a fire may be considered far greater than those received through inhaling halon gas.

Fire-fighters should note that halon 1301 decomposes at temperatures above 510°C. The amounts of hydrogen bromide and hydrogen fluoride given off will depend largely on the extent of the fire and the material which is on fire. To this end speedy injection of halon containers is essential, so reducing the quantities of products given off after decomposition.

Most surface fires would be suppressed by a concentration of approximately 5 per cent halon gas. It is extremely well suited to dealing with fires in flammable liquids and gases, and ideally suited for fires in ships' engine rooms, pump rooms, electrical switchboard and generating rooms, tank areas containing inflammable liquids or gases, computer rooms, and offshore installations. Halon 1301 is not effective, however, against reactive metals and chemicals which contain their own oxidising agent.

Halon gas has the following advantages:

1. It is a clean gas and leaves no residue.
2. It is easy and safe to store.
3. Electrically it is non-conductive.
4. It penetrates into all areas of the compartment containing the fire.
5. It suppresses incipient fires.
6. It is ideal for automatic release.
7. It possesses a low working concentration, which allows a relative safe working atmosphere for personnel.
8. It extinguishes the fire quickly and efficiently.

Its disadvantages are the following:

1. It is expensive by present-day standards.
2. It has a slightly narcotising effect on personnel who are over-exposed to it.
3. Large injection areas are generally required in pipes to deliver an effective volume of the gas.
4. It is ineffective against chemicals containing their own oxidiser.
5. It is considered unfriendly to the environment.

Note: Additional information may be obtained from the Report of the International Convention for the Safety of Life at Sea (1974), Chapters II.1 and II.2.

Mariners are advised that Halon is no longer being fitted aboard ships and is expected to be phased out totally.

INTERNATIONAL SHORE CONNECTION

This is a fitting which is normally carried by all ships in order to provide a common link between shore hydrants and ships' fire mains (Figure 7.8). It is employed either aboard the vessel itself or ashore in conjunction with local fire brigade tenders, in the event of fire breaking out while the vessel is in port. The shore connection is usually situated in such a position as to be easily accessible to Fire Brigade officers, e.g. near the top of accommodation ladders, or mate's office.

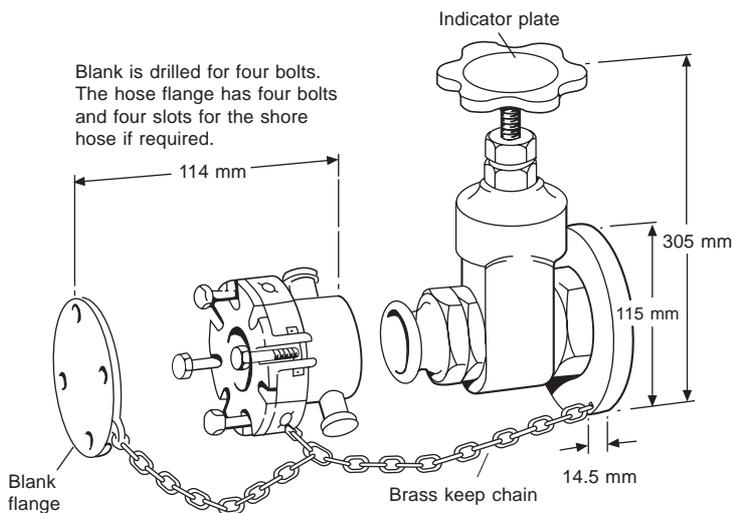


Figure 7.8 International shore connection.

SELF-CONTAINED BREATHING APPARATUS

The Siebe Gorman International Mk II, self-contained breathing apparatus (Figure 7.9) employs two cylinders of compressed air, which the wearer exhales direct to atmosphere. The cylinders are of a lightweight design, so that, when fully charged, the apparatus complete with mask weighs only 38 lb. (17 kgs). The cylinder volume is 4 litres, providing enough air for 20 minutes when the wearer is engaged on hard work. Both cylinders have the same capacity.

The amount of work carried out by the wearer will obviously affect the consumption of air, and, consequently, the time that person may continue working. The following are guidelines supplied by the manufacturer:

Hard work rate	40 minutes (twin cylinders).
Moderate work rate	62 minutes.
At rest	83 minutes.

Pre-operational Checks (monthly)

1. Ensure that by-pass control is fully closed.
2. Open cylinder valves. The whistle, if fitted, will be momentarily heard as pressure rises in the set. Check cylinders are fully charged.

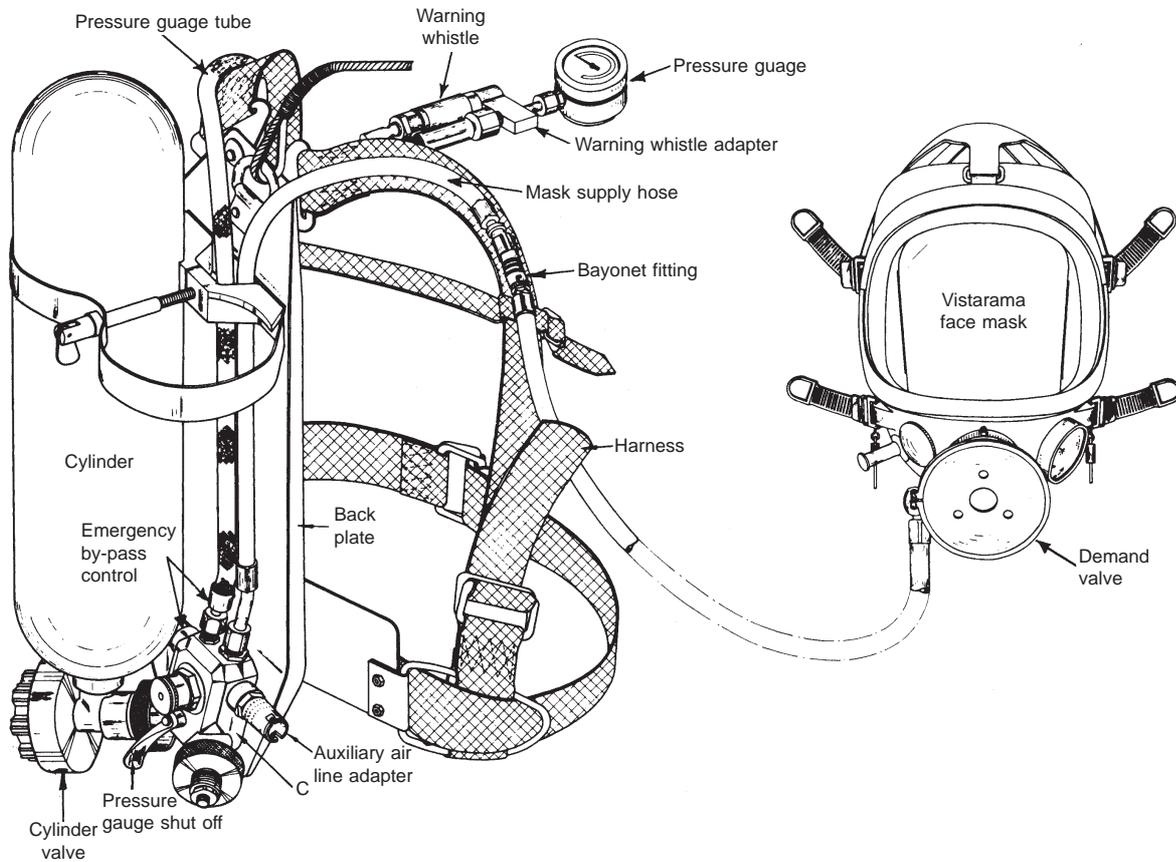


Figure 7.9 Siebe Gorman International Mark II compressed air breathing apparatus.

3. Any leaks in the apparatus will be audible and should be rectified by tightening the appropriate connections, but do not overtighten.
4. Close cylinder valves and observe pressure gauge. Provided it does not fall to zero in less than 30 seconds, the set is leak-tight.
5. Depress demand valve diaphragm to clear circuit of compressed air.
6. Close pressure gauge shut-off valve and reopen cylinder valves. The pressure should remain at zero. Reopen first valve.
7. Gently open emergency by-pass control; air should then be heard to escape from the demand valve. Close control.
8. Close cylinder valves. Gently depress demand valve diaphragm and observe pressure gauge. When it falls to approximately 43 ats. (44.5 kg/cm^2), the whistle should sound.

Preparation for Use

1. Demist mask visor with anti-dim solution.
2. Don the apparatus and adjust harness for comfortable fit.
3. Open cylinder valves. Put on the mask and adjust to fit by pulling the two side straps before the lower ones.

4. Inhale deeply two or three times to ensure that the air is flowing freely from the demand valve and that the exhalation valve is functioning correctly. Hold breath and make certain that the demand valve is shutting off on exhalation or that leakage, if any, is slight.
5. Close cylinder valves and inhale until air in the apparatus is exhausted.
6. Inhale deeply. The mask should crush on to the face, indicating an air-tight fit of both the mask and the exhale valve.
7. Reopen cylinder valves.

There are several manufacturers of breathing apparatus, and the sequence of operations may differ slightly from that described above. Caution in following correct procedures is advised in all cases, together with regular practice drills in the use of this type of emergency equipment.

EXAMPLE: CARGO FIRES

LNG (Liquid natural gas)

Natural gas contains numerous component gases but by far the greater percentage is methane (CH_4), which represents between 60 and 95 per cent of the total volume. This fact is important when considering the safety aspects for fire-fighters tackling an LNG fire.

During the initial period of vaporisation of the gas, ignition may be accompanied by a flash of varying proportions. However, because the velocity of propagation of a flame is lower in methane than in other hydro-carbon gases, it is unlikely that future ignition will have flash effect.

The fire-fighting plan should be well thought out in advance and a concentrated effort made rather than 'hit and run' tactics, as these will only consume the vessel's extinguishing facilities without extinguishing the fire. Before attempting to tackle a large fire, you should seriously consider allowing the fire to burn itself out.

Should an attempt to extinguish the fire be made, extensive use of 'dry powder' should be employed from as many dispensers as can be brought to bear. Fire-fighters should be well protected against heat radiation and possible flash burns, and approach the fire from an upwind direction. Power dispensers should sweep the entire area of the fire, but direct pressure of powder jets on to the surface of the liquid should be avoided.

Should dry powder guns be used, fire-fighters should be well practised in their use and be prepared for some kick-back effect. They should also be made aware that there is no cooling effect from the use of dry powder, and that re-ignition after a fire has been extinguished is a distinct possibility.

In the initial stages it is always preferable to isolate the fire by shutting off the source of fuel. This may not, however, always be possible.

A final warning when tackling an LNG fire is that water should not be used directly, as this will accelerate vaporisation of the liquid. This is not to say that surrounding bulkheads and decks cannot be cooled down with water sprays, provided that water running off is not allowed to mix with burning LNG.

Cotton (Class 'F' fire)

Cotton is a cargo liable to spontaneous combustion and one which is extremely difficult to bring under control. Cotton cargoes are such that they are shipped in bales of 500 or 700 lb (227 or 318 kg). A heavy cargo, cotton is often stowed in lower holds for stability reasons and to form a base for later cargo. It is cargo where the prevention of the fire initially is preferable to knowing how to tackle it, should it occur.

Cotton bales should be dry and free of oil marks, tightly bound and seen to be in good condition at the onset of loading. Stringent observation of 'no smoking' in and around cargo holds should be observed by stevedores and ship's personnel. Bare metalwork in holds should be covered to prevent moisture contact with cargo and spar ceiling should be inspected to ensure that bales do not come into contact with the shell plate.

Should an outbreak of fire occur, the only sure way of extinguishing it is to dig out the effected area. This practice is not at all easy for crew members, who are inexperienced at handling heavy bales for any length of time. Deviation to a port for discharge may become the only alternative, depending on the size of the fire at the time of discovery and the ability to extinguish it.

If successful in digging out burning or smouldering bales of cotton jettison them overboard. Re-ignition of cotton bales can occur, even after they have been totally immersed in water. Bales which appear to be extinguished will all too easily flare up after a thorough hosing down.

If breathing apparatus air supply is restricted and for other reasons it proves impossible to tackle the fire direct, containment should be the next consideration. This is probably best achieved by the battening down of the compartment and the injection of CO₂ while heading for a port with the necessary facilities. Boundary cooling should be carried out on as many of the six sides of the fire as are accessible. Any deviation of the vessel's course should be noted in the ship's log book.

Coal (Class 'F' fire)

All coal cargoes give off an inflammable gas, and when this mixes with critical proportions of oxygen, then explosion and/or fire may be the end result. The gas given off by the coal is lighter than air and during the voyage it will work its way to the upper surface of the cargo. It is essential that coal is therefore provided with 'surface ventilation' to clear away any build-up of accumulated gas. Surface ventilation is achieved during the voyage by raising the outer corners of hatch slabs (conventional hatches) or opening 'booby entrance hatches'. Steel hatch covers should be raised on their wheels, provided at all times that weather permits such action. Ventilators should always be properly trimmed.

All types of coal, whether of the 'anthracite, lignite or brown coal' varieties, are subject to spontaneous combustion. A close watch should be maintained on hold temperatures during passage and correct ventilation allowed to reduce temperatures in the event of over-heating. It is worth noting that coal increases its temperature by its absorption of oxygen. Correct ventilation for this cargo must therefore be considered to be surface ventilation only, for a limited period.

Should fire break out, early positive hose action will probably be the best way of containing it. However, personnel may not be able to spend much time on fire-fighting because of the excessive heat or the amount of smoke within the space. Breathing apparatus will be essential and the air supply in bottles may further restrict conventional means of fighting the fire.

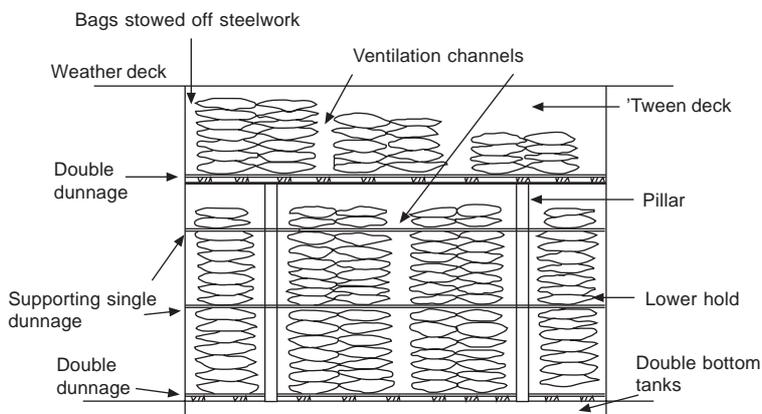
The injection of CO₂ or steam smothering must be considered at an early stage, should conventional methods become impractical. It will be totally dependent on the size of the fire whether these two agents will effectively extinguish it. At the very best they will contain the blaze to a degree and will certainly buy time for the Master to investigate safe port options. Alternatively, the final option would be to flood the space with water. Close investigation of the ship's 'damage stability notes' should be made before taking this action, with particular attention to the free surface effect of flooding such a large space, though in a compartment filled with coal there would be little free surface effect.

Hold preparation before loading coal will play a major part in averting a fire, and the following points are recommended:

1. Clean the hold space of residual debris.
2. Remove spar ceiling.
3. Remove any dunnage clear of the space.
4. Make provision for obtaining temperatures at different levels of the cargo.
5. Trim the cargo throughout and on completion of loading.

Fish Meal (Class 'F' fire)

Fish meal is a bagged cargo which is probably one of the most likely to catch fire while the ship is on passage from the loading port, due to spontaneous combustion. Experience has shown that vessels employed in the carriage of 'fish meal' must take stringent precautions when loading (Figure 7.10). Extensive ventilation channels must be allowed for at the onset of loading and these channels must not be allowed to become blocked by falling bags of cargo.



NB. Coal fires when treated with water will generate considerable volumes of steam. This steam must be vented or the compartment may become pressurised.

Figure 7.10 Fish meal stowage.

Deck officers should be particularly aware that during loading bags should be sighted to ensure they are in good condition and dry. Telltale damp stains on the bags indicate that the cargo has been exposed to rain and that the contents are wet. These bags should be rejected at all cost.

Officers should be provided with injection thermometers for the purpose of testing bags during loading. Any batch with excessively high temperatures should also be rejected. Temperatures during the voyage should be taken at least twice a day and a watch maintained on the following temperatures for every space containing fish meal:

1. Hold temperatures.
2. Ventilation inlet temperature.
3. Ventilation outlet temperature.
4. Ventilation channel temperature.
5. Random bag selection temperature.

The hold should be thoroughly cleaned and steelwork covered with insulation paper before stowage begins. Bilge suctions and scuppers should also be inspected and tested before loading. Temperature and condition of bags should be checked at the onset of loading.

Large amounts of dunnage will be required for this cargo and where stowage is to commence on a steel deck, double dunnage must be laid. It is important that all dunnage is dry and free of oil marks. Single layers of dunnage should be placed at every height of seven bags. Ventilation channels of approximately 12 in. (30 cm) should separate double tiers of bags. Provision should be made for positioning thermometers at all levels of cargo, in all spaces containing fish meal.

If there is an outbreak of fire, close off all ventilation as soon as possible after the alarm has been raised. Make an immediate assessment of the fire area, and attempt to extinguish small fires, preferably by use of dry powder.

If it is found that a major fire is already well established, ensure that all ventilation is cut off and inject CO₂. If this action fails to extinguish the blaze, then hose action may be the only alternative. Should hoses have to be brought to bear, then they should be as close to the fire as possible before being turned on. All bags of fish meal that are soaked by the hose action should be jettisoned as soon as the fire has been extinguished.

Hoses should not be used except as a last resort to save the bulk of cargo and the ship itself. Considerable spoilage of the bags will occur with hose action, and the likelihood of further outbreaks of fire becomes more probable rather than less. Correct stowage in the first instance, with continual checks on temperature conditions throughout the passage, will limit the chance of fire, and give ample warning should it occur.

SEARCH AND RESCUE OPERATIONS



ACTION BY VESSEL IN DISTRESS

A ship in distress should transmit an appropriate distress alarm signal, followed by a distress message. This message should include the following main points:

- (a) Identification of the vessel in distress.
- (b) Position of the vessel in distress.
- (c) Nature of the distress and the assistance required,
- (d) Other relevant information to facilitate the rescue, e.g. number of persons leaving the ship, number remaining on board, Master's intentions etc.

In addition to the main points mentioned above, further information regarding influencing factors should be passed on to assisting vessels. These may include:

1. Weather conditions in the immediate area of the ship in distress.
2. Details of casualties and state of injuries.
3. Navigational hazards, e.g. icebergs etc.
4. Numbers of crew and passengers.
5. Details of survival craft aboard and of craft launched.
6. Emergency location aids available at the scene of distress and aboard survival craft.

A series of short messages is preferable to one or two long messages.

Vessels in distress should use the time preceding a rescue attempt to minimise the risk of increased numbers of casualties. This could be done by reducing numbers aboard the stricken vessel by allowing non-essential personnel to disembark. Some companies now employ this technique as standard practice, but it should be used with extreme caution, and must depend on weather conditions for the launching of survival craft and the

degree of danger present aboard the parent vessel, bearing in mind that the mother ship provides the best form of protection while it remains sustainable.

MASTER'S OBLIGATIONS

In accordance with the International Convention for the Safety of Life at Sea, Masters have an obligation to render assistance to a person or persons in distress, if it is within their power. Any Master of a vessel at sea, on receiving a signal for assistance from another ship, aircraft or survival craft, is bound to proceed with all possible speed to the scene of the signal. If possible, he should inform the distressed party that assistance is on its way. If the Master of a ship is unable, or under special circumstances considers it unreasonable or unnecessary, to proceed to the scene of distress, then he must enter that reason in the log book.

The Master of a vessel in distress which has made a request for assistance has the right to requisition one or more of those vessels which have answered his distress call. It will be the duty of the Masters of those vessels so requisitioned to comply with their call to assist and proceed with all speed to the distress scene.

The Master of an assisting vessel will be released from his obligations to assist when he learns that one or other vessels have been requisitioned and that, because they are complying, his own vessel is no longer required. He may also be released from further obligation to assist by an assisting vessel which has reached the distress scene and considers additional assistance is no longer required.

OBLIGATIONS OF RESCUING CRAFT

On receipt of a distress message any vessel in the immediate vicinity of the distressed vessel should acknowledge that the message has been received. Should the craft in distress not be in the immediate area, then a short interval of time should be allowed to pass before acknowledgment of the distress signal is despatched, so that other ships in close proximity may give prior acknowledgment.

The Master should immediately be informed that a distress message has been received, and whether acknowledgment has been sent by other vessels, together with the positions of the vessel in distress and would-be rescue craft. The Master will cause an entry to be made in the radio log book, or radio telephone log.

Bearing the latter statement in mind, the Master of any vessel in receipt of a distress message may repeat that message on any frequency or channel that he knows to be in common use in that area.

WHEN ASSISTANCE IS NO LONGER REQUIRED

Any casualty having despatched a distress message and finding that the assistance being provided is adequate may effectively reduce the level of communications to those pre-fixed by the urgency signal.

Any decision to reduce communications from a distress to an urgency level must be the responsibility of the Master in command of the distressed vessel, or his authorised representative. Receiving stations should bear in mind that a very urgent situation exists and the resumption of normal working conditions must be made with extreme caution. Table 8.1 illustrates types of signal.

TABLE 8.1 Emergency signals

Type of message	Prefix radiotelephone	Prefix radiotelegraph	Frequency/channel
Distress	Mayday, Mayday, Mayday	SOS, SOS, SOS.	2182 kHz, Channel 16, or any other frequency at any time
Urgency	Pan Pan, Pan Pan, Pan Pan	XXX, XXX, XXX	
Navigation warning	Securité, Securité, Securité	TTT, TTT, TTT	

SEARCHING THE SEA

Vessels may be employed in search and rescue activities alone or with other surface craft (Figure 8.1), or with aircraft. It can be expected that a specialised unit like a warship or military aircraft would assume the duties of the On Scene Co-ordinator (OSC), and co-ordinate the other search units in the area. Communications will be established on 2182 kHz or VHF channel 16, if possible. Failing this, a relay should be established between surface vessels and a coast radio station (CRS) to aircraft.

Surface vessels when engaged with aircraft in a co-ordinated search (Figure 8.2) could expect items of a specialist nature to be dropped into a search or rescue area. These items would probably be in the form of:

1. Parachute flares for illumination purposes.
2. Individual life rafts or pairs of life rafts joined by a buoyant rope.
3. Dye markers or flame floats.
4. Buoyant radio beacons and/or transceivers.
5. Salvage pumps and related equipment.

Should specialist units not be engaged in the search area then the Master of the vessel going to the assistance of the distressed vessel must assume the position of On Scene Co-ordinator (OSC) and communicate with the coastguard.

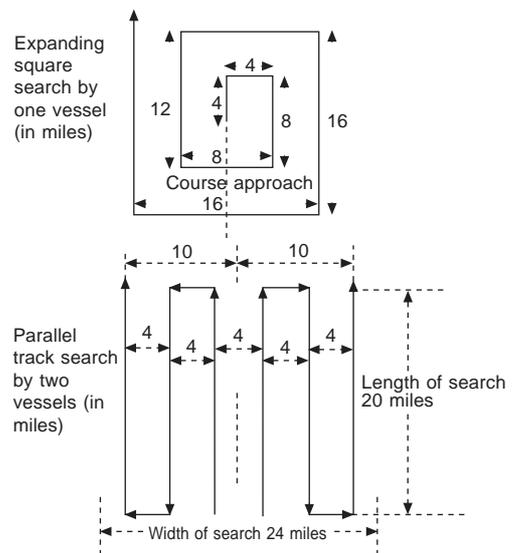


Figure 8.1 Sea search by one and two vessels.

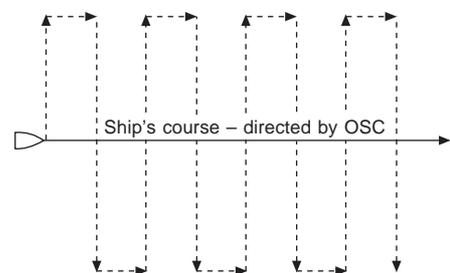


Figure 8.2 Ship/air co-ordinated search.

Under the GMDSS legislation, vessels will be required to carry two Search & Rescue Transponders (SARTs). These operate on the 9 GHz for 3 cm radar. The effective range is approximately 5 nautical miles and their function is expected to enhance search and rescue operations. The radar signature from a SART would appear initially as a line of 12 dashes on the observer's screen. This signature will change to a series of concentric circles as the range of the target is closed.

AIRCRAFT IN DISTRESS

The distress message may vary with the time available from the onset of the emergency and the effective landing or ditching of the aircraft. However, when time permits, civil aircraft will transmit a distress call and subsequent distress message as follows:

Distress call by radiotelephony

1. The spoken words 'Mayday, Mayday, Mayday'.
2. The words 'This is . . .'
3. The identity of the aircraft, spoken three times.
4. The radio frequency used in the transmission of the distress call.

Distress message

1. Either 'Mayday' or SOS.
2. The call sign of the aircraft.
3. Information relating to the type of distress and the kind of assistance required.
4. The position of the aircraft and the time of that position.
5. The heading of the aircraft (true or magnetic).
6. The indicated air speed (in knots).
7. Any other relevant information which would aid and effect a recovery operation, e.g. intentions of the person in command, nature of any casualties, possibility of ditching, survival facilities available or not.

The term 'heading' when applied to an aircraft refers to the direction of the aircraft when in the air. Allowance must then be made for wind effect to ascertain the true direction over the sea. Indicated airspeed does not take into account the effect of the wind. This should be estimated to obtain a more realistic speed over the water. If the aircraft is to be ditched, the aircraft's radio transmitter may be left in the operative position, depending on circumstances.

COMMUNICATION BETWEEN SURFACE CRAFT AND AIRCRAFT

Merchant vessels engaged in search and rescue operations (SAR) with military aircraft should maintain a VHF watch on Channel 16.

Surface vessels should use their normal call sign in communicating with an aircraft. Should the call sign of the aircraft be unknown, then the term 'Hawk', may be used in place of the aircraft call sign. When an aircraft is in the process of establishing communications with a surface craft without knowing the call sign of the vessel, the aircraft may use the inquiry call 'CQ' in place of the vessel's normal call sign.

Emergency Position Indicating Radio Beacons (EPIRBs) – Survival Craft

The regulations require that all ships constructed after 1 July, 1986 will be equipped with one manually activated Emergency Position Indicating Radio Beacon which complies with the regulations, stowed on either side of the ship. Their stowage should be such that they can be deployed in any of the survival craft rapidly, with the exception of the life rafts required by Regulation 26.1.4. (Regarding the stowage of additional life rafts on certain vessels.)

Survival craft EPIRBs shall at least be capable of transmitting alternately or simultaneously signals complying with the relevant standards and recommended practices of the International Civil Aviation Organization (ICAO) on the frequencies 121.5 MHz and 243.0 MHz. The transmission from an EPIRB shall enable aircraft to locate the survival craft and may also provide alert facilities.

Survival craft EPIRBs shall:

- (a) be of a highly visible colour, so designed that they can be used by an unskilled person. Their construction should be such that they may be easily tested and maintained and their batteries shall not require replacement at intervals of less than 12 months, taking into account testing arrangements;
- (b) be watertight, and capable of floating and being dropped into the water without damage from a height of at least 20 m;
- (c) be capable of manual activation and de-activation only;
- (d) be portable, lightweight and compact;
- (e) be provided with indication that signals are being emitted;
- (f) derive their energy supply from a battery forming an integral part of the device and having sufficient capacity to operate the apparatus for a period of 48 hours. The transmission may be intermittent. Determination of the duty cycle should take into account the probability of homing being properly carried out, the need to avoid congestion on the frequencies and the need to comply with the requirements of the ICAO.
- (g) be tested and, if necessary, have their source of energy replaced at intervals not exceeding 12 months.

See GMDSS detail on page 245–247 (Part 1)

SURFACE TO SURFACE RESCUE

Depending on circumstances, the options are the following:

1. Lower ship's lifeboat/emergency boat and begin recovery.
2. Use of rocket line, messenger and hawser to draw survival craft off the distressed vessel.
3. Go alongside the distressed vessel.
4. Establish a tow if the stricken vessel will remain afloat.
5. Head to wind and part open stern door (RoRo vessel) on to distressed vessel.
6. Use own life raft and drift survival craft towards distressed vessel on a towline.
7. Transfer personnel by breeches buoy.
8. Position rescue vessel's bow close to fo'c'sle head of distressed vessel.

Use of Lifeboat/Rescue Boat

This is by far the most favoured method of taking people off a sinking vessel, though it is only practical in comparatively good weather. Attempting to put a lifeboat down at sea in anything over a Force 6 would most surely endanger your own crew. This is not to say that it should not be attempted if no other method is available. Full use of the parent ship should be made to provide a lee for the boat when it is in the water. Transfer of personnel into a smaller craft, like a lifeboat or rescue boat, is extremely hazardous. Coxswains of rescue craft have found with experience that both vessels will probably ride easier with a following sea. To this end Masters are advised to conform to the heading and the speed dictated by the coxswain of the rescue craft. This is, of course, provided that the ship is able to manoeuvre.

Use of Rocket Line

Extreme caution should be used with this method, after first establishing good communications. A rocket should not be propelled towards a tanker, but a tanker may propel one to the rescuing vessel. Do not attempt the transfer until a messenger line has established a strong towing hawser between the two vessels.

Securing the towing hawser to a survival craft like a life raft may prove difficult. It would be unwise to secure the hawser to the towing patch attached to the life raft, as these towing patches have been known to pull adrift under excess weight. A possible method would be to punch a hole through the double floor of the raft and pass the towing hawser around the main buoyancy chamber. If this method is adopted, it would be wise to guard against rope burn by parcelling between the towline and the raft fabric with appropriate protective material. This method would mean the loss of watertight integrity inside the raft itself, but as it would not be expected to be in use for long, this would not be too serious, especially as the raft is being used for transportation and not for long term survival.

Going Alongside

An appropriate method when the weather is so bad that the launching of a rescue craft would endanger your own crew members, this manoeuvre needs extreme care to avoid structural damage to either ship. Due consideration should be given before going alongside to the risks of fire, explosion or other similar effect arising from the distressed vessel. The possibility of escaping gas from some vessels must not be forgotten, and, to this end, the direction of the wind should be considered and the subsequent approach made with extreme caution.

Apart from the type of vessel in distress, which may vary, the structure, especially freeboard, will influence the decision to take the option of going alongside. The objective of removing personnel from a sinking vessel must be given priority, e.g. higher freeboard vessels like Roll on–Roll off moving on to a small fishing craft, may well defeat the objective of saving life.

Towing

This option may not always be available to a rescue vessel. The question of the distressed vessel's ability to remain afloat long enough to complete the operation will influence any Master's decision. In any event, where there is doubt, personnel would have to be removed.

Thought should be given to the prospect of beaching the distressed vessel if suitable ground is on hand and main engine power is still available to the stricken vessel. See Chapter 6 on beaching and Chapter 9 on towing.

Special Operations (Ro Ro vessel)

Today, with specialist trades engaged on the oceans of the world, certain vessels are specially equipped to tackle specific tasks. Bearing this in mind, a Roll on-Roll off vessel may find it possible to open her stern door partly, to assist in a rescue operation. The construction of the stern door would be a determining factor, namely, the freeboard to the level of the 'hinge' must be adequate to allow such action.

It should be borne in mind that special circumstances could call for bold but not foolhardy action. Once the stern door is opened, even by the smallest amount, watertight integrity of the vehicle deck is lost. Should a main engine failure occur or hydraulics fail to operate the locking of the door when required, the watertight integrity of the ship would be lost for an indefinite period.

The recovery of physically fit survivors by means of scrambling nets over a part opened stern door/ramp cannot be ruled out as being a viable method of rescue. Use of bow thrusters to maintain the ship's head into wind would greatly assist the operation. This method would obviously be dependent on the circumstances at the time, especially the weather conditions, but may prove more acceptable than launching own boats, or causing a swamping situation by going alongside a smaller vessel with an incompatible height of freeboard.

Use of Own Life Rafts

This method could be used in circumstances where the distressed craft had no life rafts of her own or when a connection with a rocket line cannot be established. A similar method of securing the towline to the raft as that already described on p. 194 is recommended.

The disadvantage of this particular method is that control of the raft, drifting towards the distressed vessel, will be difficult, especially when compared with transfer by use of the established messenger, as described on p. 193. The use of oil should be considered if sea conditions warrant such action, but caution should be exercised, especially if there are survivors in the water or about to enter the water.

Use of Breeches Buoy

This is a very doubtful proposition and would be extremely difficult to carry through successfully. The operation is complicated and requires crews to be well practised and experienced in the ways and methods of transfer and replenishment at sea. Exceptional ship-handling would be required by the rescuing vessel, and it would be unlikely for the average merchant vessel to have the required expertise and equipment to complete such an operation.

This is not to say that it could not be achieved, but even a naval vessel, well practised in transfer by jack stay, would expect to encounter some difficulty with such a rescue operation. The weather conditions would undoubtedly decide the matter. In bad weather it would be impossible, and in fine weather the use of lifeboats or rafts would be a better proposition (see also pp. 198–203).

Vessels in Contact

This option may be compared with going alongside, but the advantage is that your own crew are removed from the dangers associated with putting a survival craft into the water. It may be an appropriate option when the freeboards of both vessels are different, so that the height of the fo'c'sle head deck is above that of the distressed vessel. By the added use of scrambling nets over the bow on to the distressed vessel survivors may be recovered.

The structure of the majority of ships might make this method possible, because of the increased scantlings and additional strength in the fore end. Superficial damage may occur and this should be considered before attempting the operation. Skilled ship-handling will be required to bring about a successful conclusion.

Use of Oil

In special operations such as those described above the prudent use of oil on the water surface can be dramatically effective. The type of oil recommended is a light vegetable or animal oil, or even light diesel oil if that is all that is available. Fuel oil should not be used. After oil has been used, a statement should be entered into the oil record book and ship's log book.

PYROTECHNICS

Smoke signals, rockets and distress flares may all attract the attention of rescuers to those in distress (see Figures 8.3 to 8.7).

Para Red Mk 3

A hand-held distress signal rocket

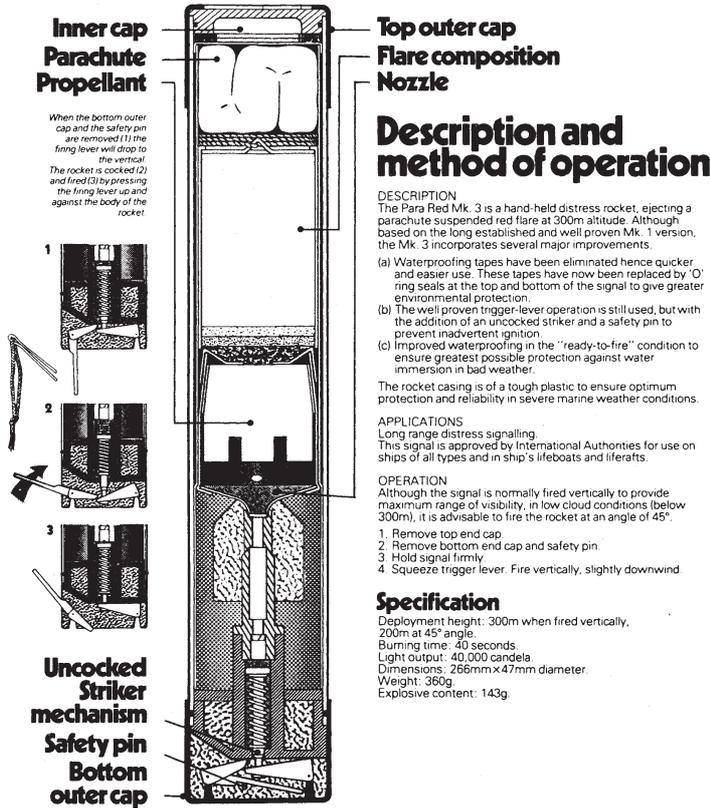


Figure 8.3 Distress signal rocket.

Rocket Parachute Flare

These shall be contained in a water-resistant casing having brief instructions or diagrams printed on the outside regarding their operation.

The rockets when fired vertically reach an altitude of not less than 300 m and, at or near the top of its trajectory, shall eject a parachute flare.

The flare will burn bright red in colour, and will burn with an average luminous intensity of not less than 30,000 cd. The burning period should be not less than 40 s, and have a descent rate of not more than 5 m/s. The parachute should not be damaged while burning.

Pinpoint Mk 6

A hand-held red distress flare

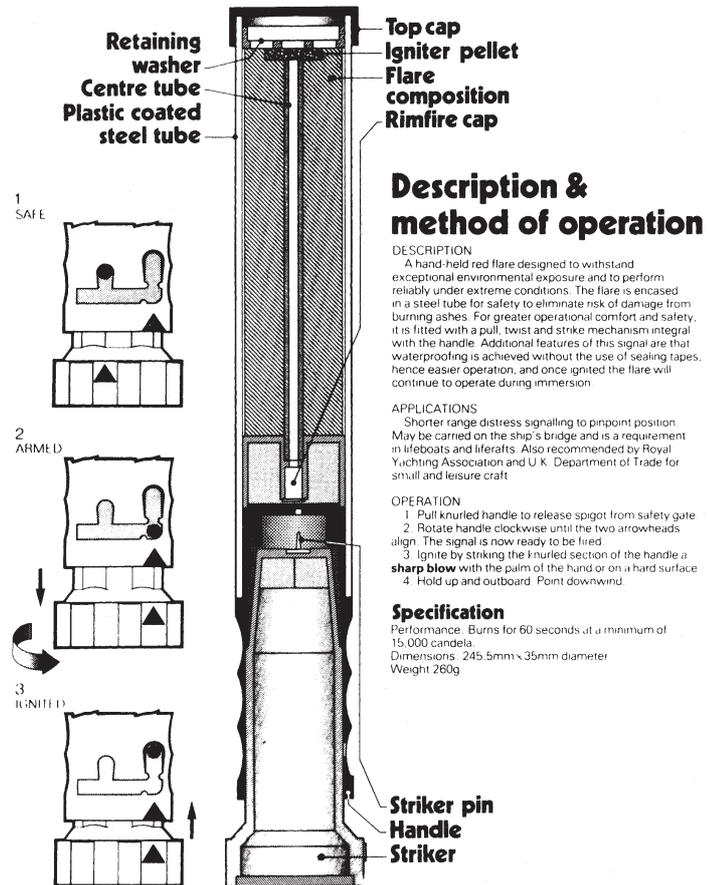


Figure 8.4 Distress flare.

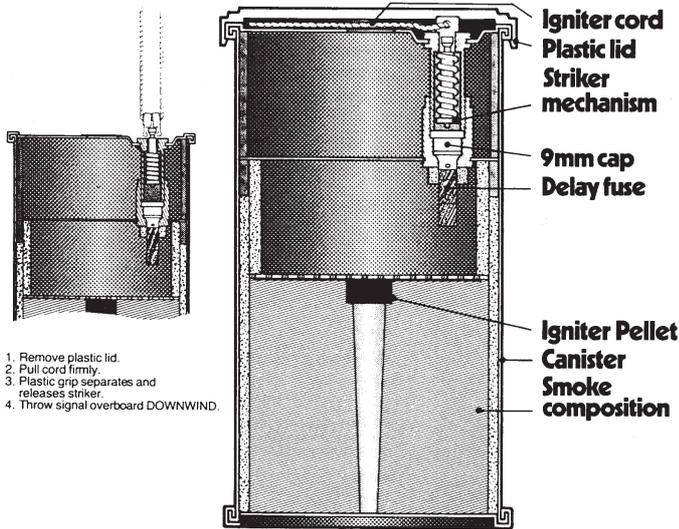
Hand Flares

These shall be contained in a water-resistant casing having brief instructions or diagrams illustrating their operation, printed on the outside.

The hand flare shall burn with a bright red colour with an average luminous intensity of not less than 15,000 cd. The burning period shall be not less than 1 min and should continue to burn after being immersed for a 10 s period under 100 mm of water.

Lifesmoke Mk 3

A buoyant orange smoke signal



1. Remove plastic lid.
2. Pull cord firmly.
3. Plastic grip separates and releases striker.
4. Throw signal overboard DOWNWIND.

Description and method of operation

DESCRIPTION

A buoyant orange smoke signal safe to operate on petrol or oil covered water. The signal consists of a metal case containing smoke composition and is fitted with a simple pull-cord ignition.

APPLICATION

Daylight distress signalling. Required in ship's lifeboats and suitable for use in other commercial and pleasure craft.

OPERATION

The unit has been designed for maximum ease of operation:

1. Remove plastic top cap.
2. Grasp cord firmly and pull vertically.
3. Throw signal overboard downwind.

Specification

Performance: Produces dense orange smoke for 3 minutes. Dimensions: 160mm x 85mm diameter. Weight: 459g.
Note: A 4-minute smoke duration version is available to special order.

Figure 8.5 Buoyant smoke signal.

Buoyant Smoke Floats

These shall be contained in a water-resistant casing having brief instructions or diagrams regarding their operation printed on the outside of the case.

A buoyant smoke float should not ignite in an explosive manner but when activated in accordance with the manufacturer's instructions it should emit smoke of a highly visible colour at a uniform rate for a period of not less than 3 min when floating in calm water. It should not emit any flame during the time of the smoke emission neither should the signal be swamped in a seaway. It must be constructed in a manner so as to emit the smoke when submerged in water for a period of 10 s when under 100 mm of water.

Handsmoke Mk 2

A hand-held orange smoke signal

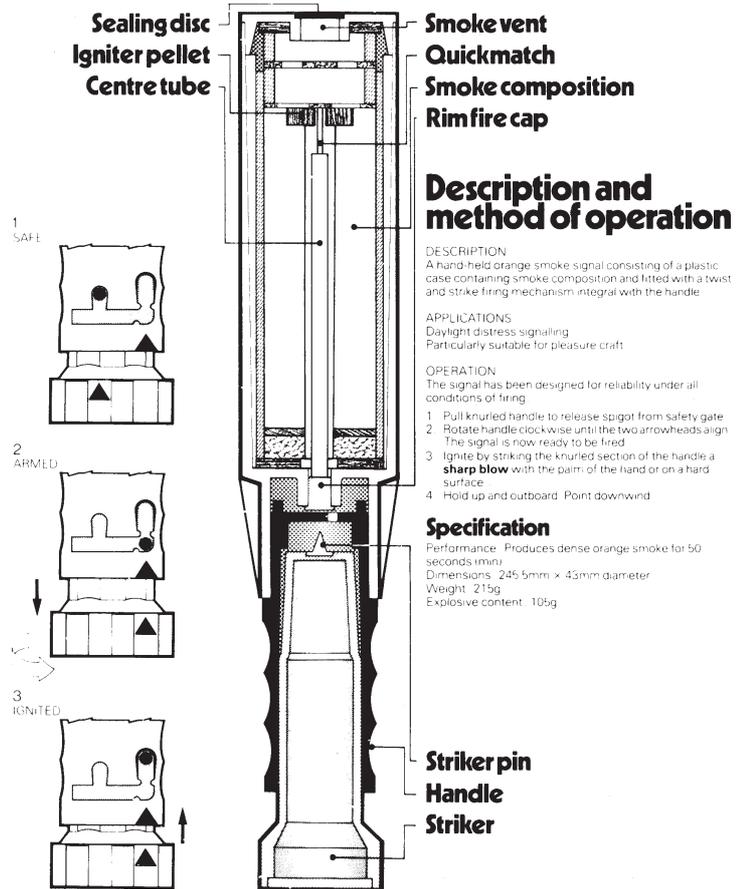


Figure 8.6 Smoke signal.

BREECHES BUOY

Provided that the distressed vessel is within 230 m of the coast line rescue may be carried out by means of the breeches buoy. This distance may be increased, however, by use of the coastguards' more powerful rocket line apparatus.

There are several methods of carrying out a rescue by means of the breeches buoy and the more popular methods are shown in Figures 8.8 and 8.9. The hawser method is being phased out by the coastguards in favour of the heath jack stay method.

Manoverboard

An emergency light and smoke marker

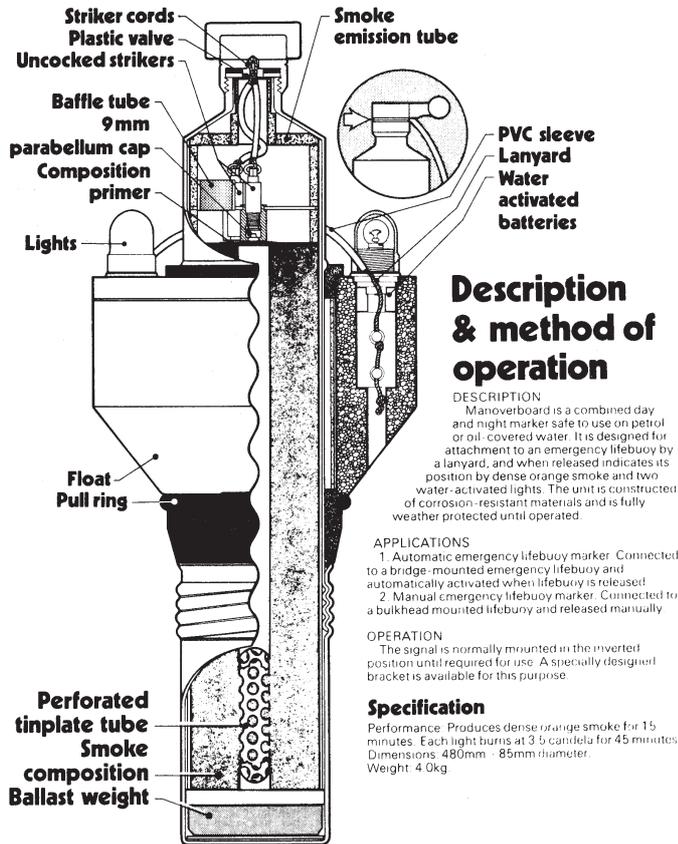


Figure 8.7 Light and smoke marker for 'man overboard' emergency.

Securing Whip to Hawser

Seafarers in the past have experienced some difficulty in understanding how the hawser is secured to the whip for the purpose of hauling off to the stricken vessel. The recognised method employed by the coastguard is as follows.

A bight is formed in the whip and with this bight a clove hitch is formed about 2 m from the bare end of the hawser.

The end of the hawser is then passed around part of the whip and secured by a bowline on itself. This virtually makes a running bowline about the whip. The purpose of this double method of securement, namely the clove hitch and the bowline, enables the bowline to be cast off and the hawser tail secured before the clove hitch is released.

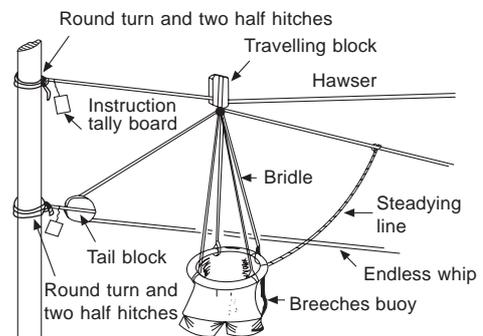


Figure 8.8 Rigging the breeches buoy.

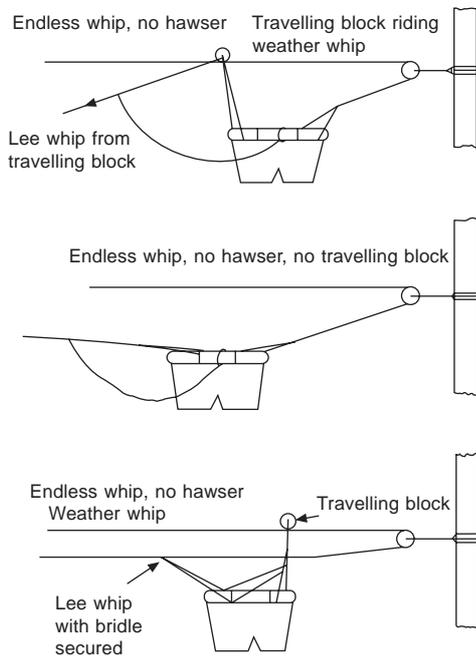


Figure 8.9 Alternative rigs for breeches buoy.

These methods of rescue are not used regularly by British coast guards.

NB. The use of helicopters have generally superseded the use of breeches buoy operations

At no time during the operation is the hawser left unsecured. Consequently, it cannot be accidentally let go and lost. When securing with the hawser method, mariners should remember that it is important to pass the tail end of the hawser up between the two parts of the whip once the bowline has been cast off. The hawser is secured by a round turn and two half hitches approximately 1–2 m above the secured tail block.

General Notes on Use

It is not uncommon for rescue methods by means of the breeches buoy technique to vary from coast station to coast station. Although the principles are the same wherever the operation is performed, geography and circumstances may necessitate variations in method.

For example, survivors may be hauled ashore through the water rather than above it. If this method is used, the occupants of the buoy may fare better if placed in backwards. This position will allow the breathing passages to remain clear, reducing the risk of drowning while being pulled ashore.

The possibility of inflating a life raft and securing it to a travelling block in place of the single buoy should not be ruled out. The raft would of course, be pulled through the water, and the method might be chosen when a considerable number of people have to be rescued.

The successful rescue of children and injured people always poses serious problems. The fact that the rescue is being attempted at all would indicate that the ship will almost certainly break up with loss of life if the attempt is not made. In these circumstances, any persons rescued must be considered fortunate. The saying 'better to have tried and failed than never to have tried at all' may be appropriate. Small children are best placed in the breeches buoy in a sling or in the strong arms of an adult. Sending a child with an adult may tax the gear being used, and the order in which they should go should be carefully assessed at the time.

With regard to injured persons, the way in which they are handled will depend on the state of their injuries. The shore party may have the advice of a doctor, but this cannot always be assumed. Limited equipment in the way of Neil Robertson stretchers may not always be readily available either.

Sometimes the breeches buoy may be used in reverse. Once in Northern Ireland it was used to send fire brigade officers aboard a ship to inspect explosive and gaseous cargoes.

Rocket Line Throwing Apparatus

The rocket line throwing apparatus (Figure 8.10), once fired, will be affected by the force of the wind acting on the rocket line. The rocket, however, should be aimed directly at the target or if anything a little downwind of the target, but never into the wind. The manufacturers tend to build into the rocket a limit of deflection. This is not always the case but when the deflection is taken into account, it equates to

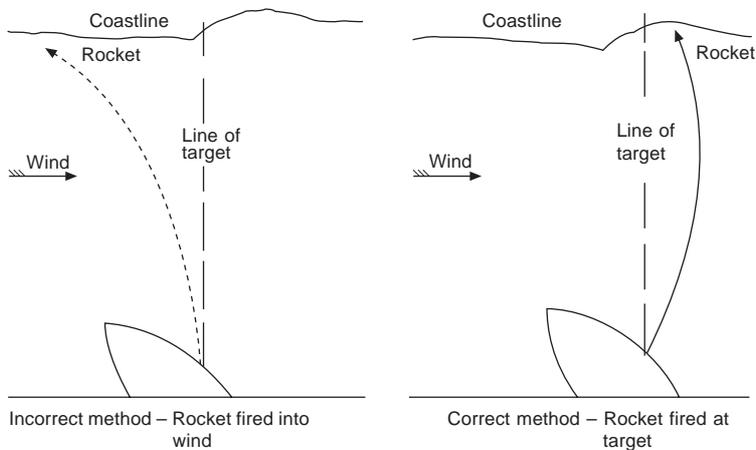


Figure 8.10 Firing rocket and line.

approximately 10 per cent of the range of the apparatus (23 m in normal range of 230 m, either side of target). The weight of line acts as a drag on the flight of the rocket, providing essential weight to the directional flight.

Efficient communications between target and operator should first be established to ensure that it is perfectly safe to fire a rocket towards the target. Should a tanker or gas carrier be the target, the firing of a rocket may prove hazardous. The signal 'GU' may be exhibited to mean 'It is not safe to fire a rocket'.

The regulations effecting the line throwing appliance

Every line throwing appliance shall be capable of throwing a line with reasonable accuracy and carrying the line at least 230 m in calm weather conditions. It should comprise not less than four projectiles and four lines each with a breaking strength of not less than 2 kN. The rocket, in the case of a pistol fired rocket, or the assembly, in the case of integral rocket and line, should be contained in water-resistant casing. All the equipment is then contained in a weather-proof container.

Every cargo and passenger ship must be provided with a line throwing appliance as stated, in compliance with Regulations 17 and 49, of the amended SOLAS requirements. Instructions in the use of this equipment must also be provided for the use of personnel.

COMMUNICATIONS

To carry out any rescue operation efficient communications between all parties are essential. They may be established in many forms, but radiotelephone and VHF are the best. Should these be unavailable, owing to damage, loss of power, or weather interference, alternative methods must be adopted. These may be one or a combination of the following:

1. Shouting, word of mouth, distance and weather permitting.
2. Morse code by flashlight or sound.
3. International flag hoists.
4. Morse by flags.

HM COASTGUARD

The coastguard service is in operation all round the UK coastline (Figure 8.11) at 300–350 active stations. These stations have greater or less priority and comprise:

Divisional Rescue Headquarters	(DRHQ)
Rescue Headquarters	(RHQ)
Constantly manned stations	(CMS)
Coastguard stations	(CS)
Auxiliary units:	
Watch-rescue equipment	
Rescue equipment	

All coastguard stations are equipped with radio communications, VHF channel 16.

One of the main functions of the coastguard organisation is to handle rescue operations in the event of a distress or emergency on or near the UK coast. Consequently, men have to be trained and equipped to carry out rescue operations correctly.

The coastguard service operates a watch system, normally six men to a watch, but this number may be increased if demand requires. Co-ordination of any rescue operation is carried out at the DRHQ or the RHQ nearest to the scene of distress.

Each operation will depend on circumstances, but as a general rule an ‘On Scene Co-ordinator’ (OSC) will be nominated – maybe the pilot of a rescue helicopter, a naval officer, or even the Master of the vessel in distress. Efficient communications between all parties are essential, so that the OSC will be able to communicate either directly or via a relay to helicopters, lifeboats, ships, aircraft or coastal station.

Since the man on the spot is the one who knows what is going on, it is up to him to make decisions regarding the use of helicopters, aircraft etc. whether the local lifeboat station should be called in, or whether a combined operation should be made. Action to save life at sea must be taken by the OSC.

Training

Most personnel are drawn from a marine background, and are provided with some amount of first-aid training, and training in radio communication and international code flag signalling methods. Professionals such as doctors, linguists etc. can be called upon if required.

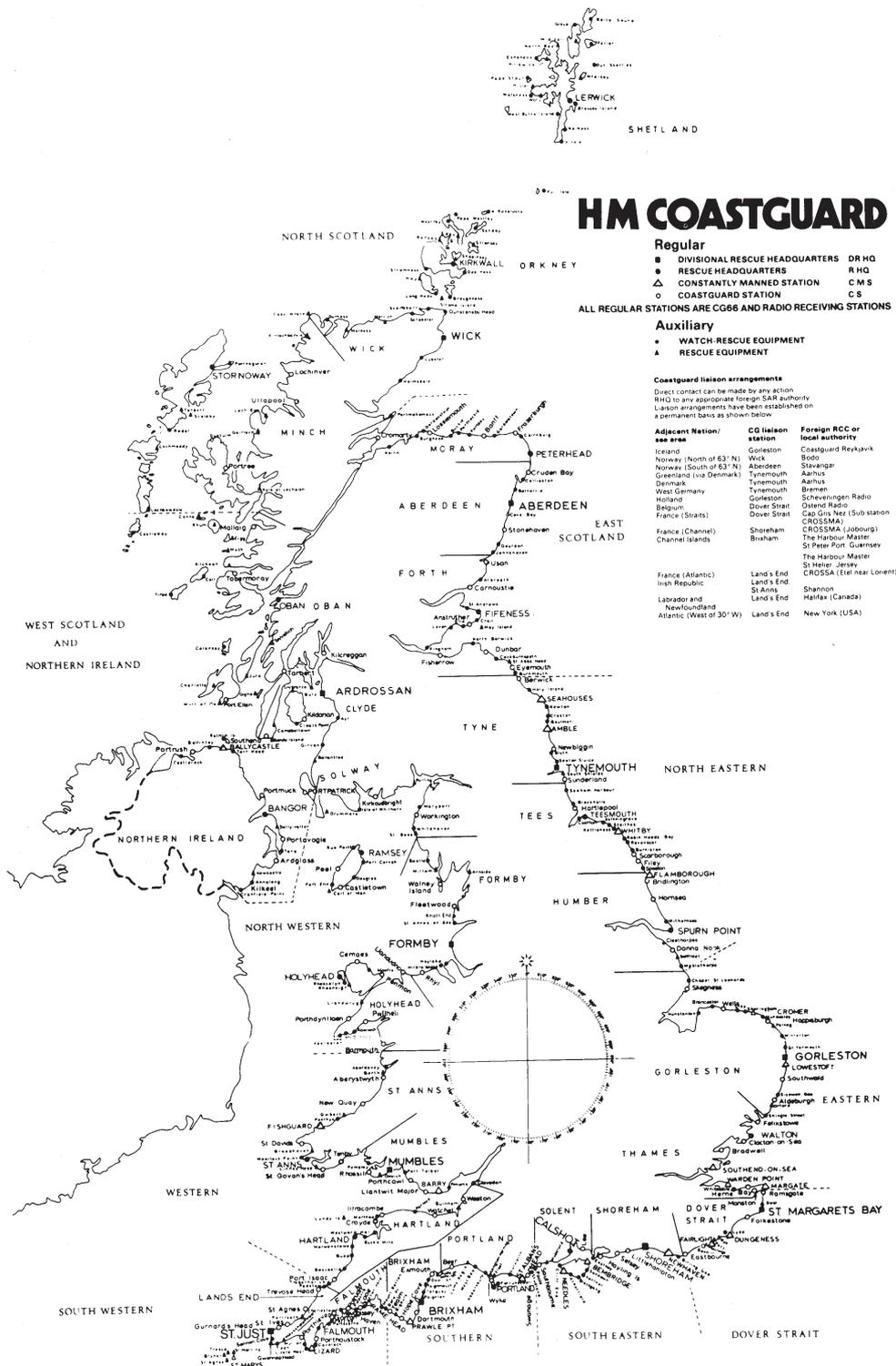


Figure 8.11 HM Coastguard stations.

		Form Approved OMB No. 04-R3073
MESSAGE		
Automated Mutual-assistance Vessel Rescue (AMVER) System "that no call for help shall go unanswered"		
1 Name	2 Call sign	3 Type
4 Position	5 Date-Time GMT	
6 Sailing Route		
6 Sailing Route		
6 Sailing Route		
7 Speed	8 Destination	9 ETA
10 Call sign of commercial radio station guarded this voyage (please list twice)		
11 Medical personnel onboard this voyage (Doctor, Paramedic, no medic)		
To ensure that no charge is applied, all AMVER messages should be passed through specified AMVER radio stations		

Dept. of Trans., USCG, CG-4796 (Rev. 6-78)
Previous editions are obsolete

Department of Transportation
United States Coast Guard

Message Types & Format

TYPE 1 – The complete Type 1 report consists of eleven parts and any pertinent remarks and contains the information necessary to initiate a plot. It is called an initial AMVER message and may be considered a movement report or sailing plan. Type 1 reports may be sent immediately prior to departure, immediately after departure, or as soon as adequate communications can be established.

TYPE D – The Type D report is a deviation report and need include only information which differs from that previously reported. It is sent when the actual position will vary more than 25 miles from the position which would be predicted based upon data contained in previous reports. It may indicate a change of route, course, speed, or destination and can include any pertinent remarks.



TYPE 2 – The Type 2 report is considered a position report and includes the date and time of the position. It may contain additional entries and remarks. During long passages, it is suggested that Type 2 reports be submitted at 36-hour intervals to insure accuracy of the computer plot, Parts 6, 7, 8, and 9 may be omitted from the message if desired. Positions are also extracted from weather reports from ships participating in the international weather observation program.

TYPE 3 – The Type 3 report is an arrival report and is sent upon reaching the harbor entrance at port of destination. Parts 6, 7, 8, and 9 may be omitted. If communications cannot be established, the computer will automatically terminate the plot at the predicted time of arrival. However, the report is desired to increase the accuracy of the plot. Type 3 reports are especially desired upon arrival at the harbor entrance of United States ports.

Name 1	Call sign 2	Report type 3	Position 4	Date-time 5	Sailing route 6	Speed 7	Destination 8	ETA 9	Commercial station 10	Medical personnel 11
Name of ship	Radio call	1, D, 2 or 3	Latitude & Longitude to nearest 10th degree (name of point may be used if convenient, i.e. Ambrose)	Date-Time GMT of position, (Use 6 digit, i.e. 041800. first 2 are month last 4 are GMT hours and minutes)	Latitude & Longitude to nearest 0.1 degree of each turn point along intended track, Use "RL" for rhumb line or "GC" for Great Circle before each point to show method of sailing. When track is to be coastal, state "Coastal".	To Nearest 0.1 kt	Next Port of Call	Estimated Time of Arrival at destination GMT	Call sign of commercial station to be worked on voyage. (List twice)	Doctor, Paramedic, or No Medic.

ANY VESSEL OF ANY NATION DEPARTING ON AN OFFSHORE PASSAGE OF 24 HOURS DURATION OR GREATER IS ENCOURAGED TO BECOME A PARTICIPANT IN THE AMVER SYSTEM BY SENDING APPROPRIATE AMVER MESSAGES.

Figure 8.12 AMVER message.

Operations

Depending on the circumstances of the case, the coastguards' main assets are that with efficient communications they can obtain assistance from the Royal Navy, RAF, Army units, commercial shipping, RNLI (lifeboats) and coastal stations, and they have extensive local knowledge. Helicopters or Nimrod aircraft may be used if the situation demands, but the use of these is limited because of range and restrictions on operating in bad weather conditions. The time factor also plays a large part in helicopter operations, flying time being limited by the fuel capacity of the aircraft. Search and rescue (SAR) helicopters are normally of the Sea King/Wessex type, with an effective range of 200 miles approximately; the actual range of these aircraft is in fact considerably greater but allowance must be made for hovering over and above the scene of operation.

Several points arising from operations should be mentioned:

1. Coastguards can order ships to divert for the purpose of SAR.
2. Communications between the RNLI and the coastguards are very good.
3. Helicopter use is restricted, as bad weather conditions (winds over 50 knots) sometimes prevent helicopters becoming airborne.

Procedure on Receipt of Distress Signal

1. Signal received by telephone, police, radio, VHF or by visual sighting.
2. Acknowledge receipt of the distress message by orange smoke, four white star shells, maroons, or radio.
3. Raise the alarm and advise RNLI of situation. Alert potential rescue forces. Ask helicopter to stand by. Alert local coastguard station.
4. Nominate On Scene Co-ordinator.
5. Obtain assessment report from OSC.
6. Despatch rescue equipment if required, e.g. rafts, pumps, etc.
7. Start systematic plot of the distressed ship's position. Obtain tidal information and weather information to ascertain probable rate of drift.
8. Enter events as they occur in coastguard log book.
9. Update report from OSC.
10. Order additional rescue forces to the scene or specialist units if required, e.g. lifeboat, helicopter, Nimrod etc. Should an operation be set in motion, the Rescue Co-Ordination Centre would order up specialist units as soon as a full assessment of the situation had been made.

AMVER ORGANISATION

The Automated Mutual-assistance Vessel Rescue (AMVER) system is a ship position-reporting system operated by the US Coastguards covering the whole of the Atlantic and Pacific Oceans. Other systems are in operation, e.g. AUSREP, about the Australian Coast, but the AMVER system is more familiar to mariners in the northern hemisphere.

The AMVER organisation exists to provide information regarding the positions and intended future movements of merchant vessels making offshore voyages. This information can be co-ordinated in the event of a maritime emergency, and an effective rescue attempt.

Voluntary information from participating vessels is transmitted to the Coastguard Centre, New York, via selected radio stations, in the form of one of four standard messages (Figure 8.12). The information is fed to a computer which constantly updates the particulars on every vessel to its next port of call. Position-fixing of vessels is done by the 'dead reckoning' method, based on the vessel's last known speed and course. Masters are requested to update their positions every 48 hours.

Standard Types of AMVER Message

1. The complete Type 1 report consists of eleven parts, together with any pertinent remarks, with enough information to initiate a plot. It may be considered a sailing plan sent before, at, or immediately after departure, as soon as communications have been established.
2. This is considered a position report and includes the date, time and the position of the vessel. Occasional position reports are necessary during long passages to ensure that the computer will predict future positions with acceptable accuracy.
3. This is the arrival report, despatched on arrival at the harbour entrance of the port of destination. Should communications have ceased, then the computer will automatically terminate the plot. However, the report is desired to check the accuracy of the plotting system.
4. This is the deviation report, and need only include information which differs from the previous report. It is transmitted when the actual position will vary more than 25 miles from predicted position as based on previous reports. It may include a change of course, speed or destination, together with any pertinent remarks.



26. RAF Wessex helicopter with aircrew actively engaged on the recovery wire.

ABBREVIATIONS

AMVER	Automated Mutual-assistance Vessel Rescue system.
CRS	Coast Radio Station.
D/F	Direction Finder.
EPIRB	Emergency Position Indicating Radio Beacon.
ETA	Estimated Time of Arrival.
FRC	Fast Rescue Craft.
GMDSS	Global Maritime Distress and Safety System.
IAMSAR	International Aeronautical and Maritime Search and Rescue Manual.
INTERCO	International Code of Signals.
MRCC	Marine Rescue Co-ordination Centre.
MRSC	Marine Rescue Sub-Centre.
OSC	On Scene Co-ordinator.
RCC	Rescue Co-ordination Centre.
SAR	Search and Rescue.
SART	Search and Rescue Radar Transponder.
SRR	Search and Rescue Region.
USCG	United States Coast Guard.

SHIP-HANDLING



TERMS AND GENERAL DEFINITIONS

Cavitation

That empty cavity, caused by the ship's displacement which is re-filled by water flowing down the ship's sides as the vessel moves ahead.

Con

'To take the con' is an old-fashioned term meaning to take *control* of the navigation of the vessel. It is still occasionally encountered, especially in the United States (conn). Submarines take the term 'conning' tower from the same word. It also implies *conducting* the navigation of the vessel by giving orders to the helmsman.

Drag

The frictional resistance caused by the ship's hull, drag in some parts of the world is also used to describe the difference between the forward and after draughts.

Headreach

The distance a vessel will continue to travel forwards after the main engines have been stopped is the headreach.

Helmsman

A person designated to steer the vessel manually is the helmsman. Helm orders used to apply to the tiller but after the First World War began to be accepted and related to the rudder.

List

A vessel which is not on an even keel in the upright position but heeled over to one side or another is listing.

Pitch

Defined as the axial distance moved forward by the propeller in one revolution through a solid medium. Measurement may be achieved by use of a pitchometer or by practical calculation in dry dock.

Pivot Point

A position aboard the vessel about which the ship rotates when turning is called the pivot point. In ships of conventional design (midships accommodation) the pivot point was approximately one-third the length of the vessel measured from forward when the ship was moving ahead. The pivot point changed when the vessel was going astern.

Quartermaster

In the modern merchant service a senior helmsman, is called a quartermaster especially in large passenger vessels. The term was previously applied to a petty officer who assisted the Master and officers.

Set

Set is a term used to describe the movement of a vessel which is being influenced by tide or current that the course being steered is not truly representative of the track the vessel is making. A vessel under such influence is often described as 'setting down'.

Sheer

(a) Defined as the angle that a ship will lie to her cable when at anchor.
 (b) Sheer may also be used to describe the upward curvature of the uppermost continuous deck – hence the term 'sheer strake'.
 (c) A vessel may also sheer away from her intended heading, so making a sharp alteration of course.

Squat

A term to describe the bodily sinkage of a vessel when under way and making way, squat is most noticeable in shallow water. Its value will vary proportionally to the square of the speed of the vessel. A vessel affected by squat may experience an increase in the forward draught and a subsequent change of trim when making way through the water, with possibly critical consequences to the handling and steerage of the vessel.

Stopping Distance

This is the minimum distance that a vessel needs to come to rest over the ground. Speed trials for new tonnage normally include test runs to provide information to watch officers showing the time and distance a vessel will take to stop (a) from full ahead after ordering main engines to stop, and (b) from crash full astern (emergency stop) (see Figure 9.1).

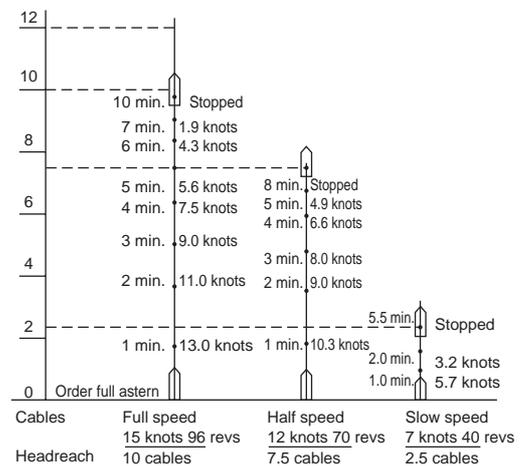


Figure 9.1 Stopping distance of vessel with particulars given.

18,000 tonnes	DWT
Draught forward	28'3"
Draught aft	30'3"
Crash stop	from full ahead to full astern

Way

When a vessel starts her main engines and begins to increase speed, she *gathers way*. When she is moving forward over the ground, irrespective of speed, she is *making way*. When the speed of the vessel will still affect and obtain a correct response from the rudder, she has *steerage way*. When the vessel is moving over the ground in the direction of the stern, under reverse propulsion, she has *sternway*. When a vessel is under way and making way and proceeding at a speed considered excessive for the prevailing conditions and situation, she has *too much way*. Finally, *under way*, as defined by the Regulations for the Prevention of Collision at Sea, means that a ship is not at anchor, or made fast to the shore, or aground.

Weather Side

This term refers to that side of the vessel exposed to the wind. Seas may be seen to break over the weather side as opposed to the lee side, which is the sheltered, favoured side of the vessel.

Yaw

Wind and sea astern of the vessel make 'yawing' about a real possibility, but this is not to say that the vessel would not behave in a similar manner if the weather was affecting the vessel from another direction. A vessel is said to yaw when, either by accident or design, her head falls off the course she is steering. Yawing is often a consequence of a following wind and sea.

FACTORS IN SHIP-HANDLING

The construction of the modern vessel will soon be such that controllable pitch propeller, bow thrust unit, stabilisers etc. will become the norm rather than novelties. However, the initial cost of installing specialised equipment of this nature is very high. Consequently, it will be some time before every owner accepts the new developments in equipment as standard.

Controllable

1. Main engine power.
2. Propeller or propellers. Fixed or controllable pitch.
3. Anchors.
4. Mooring ropes.
5. Rudder movement.
6. Bow thrust (if fitted).
7. Bow rudder (if fitted).
8. Tugs. (May be classed as controllable only as long as they respond as requested. Ship-handlers may find that tugs should be included in the following list of uncontrollable factors.)

Uncontrollable

1. The weather.
2. Tide and/or current.
3. Geographical features such as shallow water, floating obstructions, bridges and ice accretion.
4. Traffic density.

RUDDERS

Unbalanced Single Plate Rudder

The rudder stock and all pivot points (pintles and gudgeons), including the bearing pintle lie on a straight line. It is no longer used for large constructions because of alignment problems but is occasionally seen on smaller vessels—coastal barges and the like. The rudder is defined as being ‘unbalanced’ because the whole of the surface area is aft of the turning axis.

Semi-balanced ‘Mariner’ Type Rudder

This is a very popular rudder for modern tonnage, especially for the container type vessel and twin-screw vessels. The term ‘semi-balanced’ refers to the amount of surface area forward of the turning axis. If the proportion of surface area is less than 20 per cent forward of the axis, then the rudder is said to be semi-balanced.

Balanced Bolt Axle Rudder

The surface area of the rudder is seen to be proportioned either side of the ‘bolt axle’. In fact, the amount of surface area will vary but generally does not exceed 25 to 30 per cent forward of the axle. The advantage of a balanced rudder is that a smaller force is required to turn it, so that smaller steering gear may be installed at lower running cost. Ideally a reduction of torque is achieved because the rudder is turning about a more centralised position, which would not be experienced with, say, the unbalanced plate rudder already mentioned. Balanced rudders are of streamlined construction, which reduced drag.

Balanced Spade Type Rudder

A very widely used rudder, especially in vessels engaged on short voyages, such as ferries and Roll on–Roll off ships. It is, however, not common in other types of vessel. The main disadvantage is that the total weight of the rudder is borne by the rudder bearing inside the hull of the vessel.

Modern Advancers – Rudder Construction

The duct arrangement forward of the propeller has been tried and tested and shown to improve hull resistance as well as homogenise the flow on to the propeller. Today’s concept is to build in a reaction fin which will generate a reverse flow on to the propeller, and so improve the efficiency

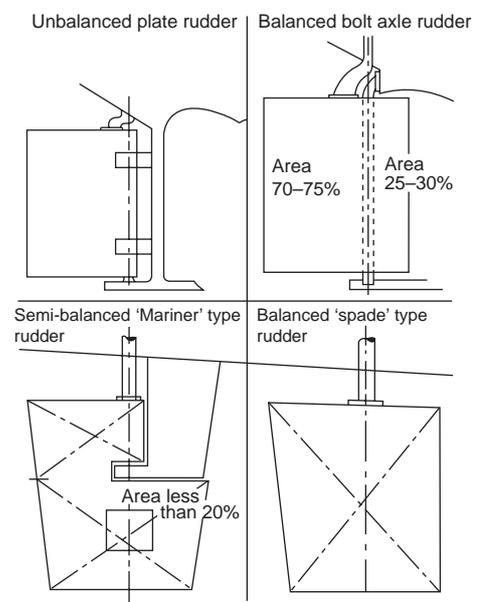
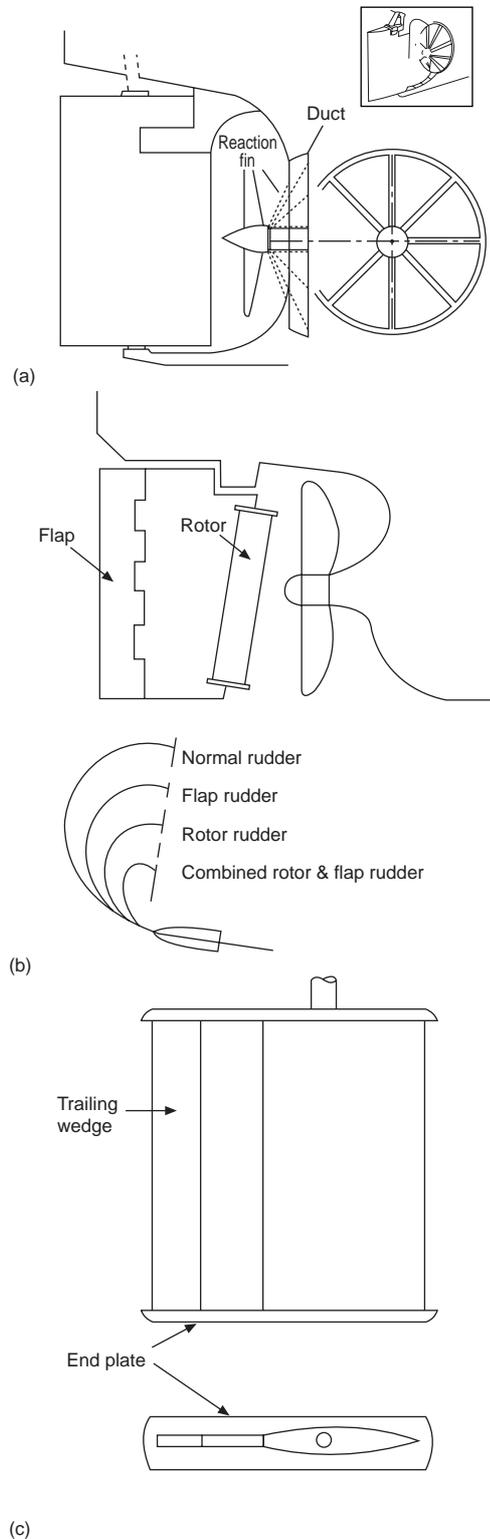


Figure 9.2 Types of rudder.



of the propeller by reducing transverse effects. This is a new development which is said to counter the effects of cavitation, reduce vibration and improve manoeuvrability.

Figure 9.3(a) (inset) shows a perspective view of the assembly.

Combined Rotor Cylinder with Improved Flap

Developments with rotors and flaps have greatly affected the turning circles and the manoeuvrability of vessels so equipped. The main disadvantage of these comparative recent advances within the marine industry are the additional maintenance problems because of the added moving parts.

Comparable turning arcs would seem beneficial to specialist craft which require more in the way of demanding manoeuvres. The cost of installation is an obvious disadvantage for the ship's owners, when compared with a normal rudder.

The Schilling Rudder

The 'schilling rudder' may be a fully hung spade or lower pintle simplex type, the balance is usually about 40 per cent. The rudder angle, at the full helm position is 70° – 75° , providing the vessel with the manoeuvrability to turn on its own axis.

The hydrodynamic shape of the rudder helps to extract the slipstream from the propeller at right angles, when at the maximum helm position. This capability, which employs the main engine power, virtually acts as a stern thruster providing an effective sideways berthing facility. The build of the rudder is quite robust and with no moving parts it is relatively maintenance free, if compared to the rotor or flap types. Other features include the end plates which help to reduce pitching and absorb impact, so giving limited protection to the main body of the rudder. The 'trailing wedge' reduces the yaw of the vessel providing course stability with the minimum of helm movements necessary.

Further development has led to the 'VecTwin system' which employs twin rudders with the single propeller. A conventional wheel being used to operate rudders in tandem when engaged on passage and a single joystick control for more involved manoeuvres. The system can provide 70 per cent of the ahead thrust in a sideways direction and up to 40 per cent astern thrust. The large helm angles are capable of reducing the stopping distance by 50 per cent of a conventional ship when the rudders are in the 'reflectance', 'clamshell' position.

Figure 9.3 (a) Reaction fin with duct arrangement; (b) combined rotor cylinder with improved flap; (c) Schilling rudder.

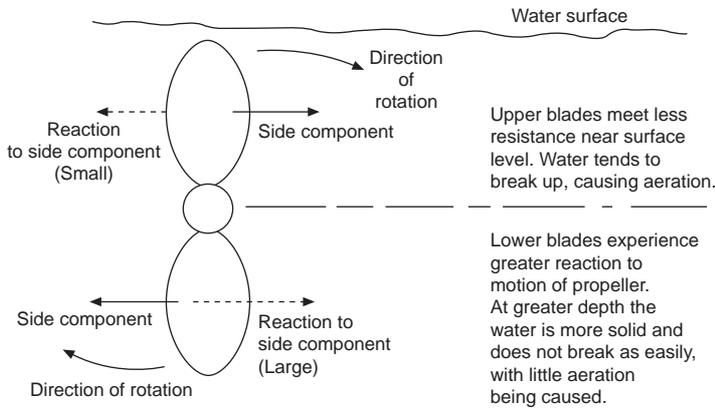


Figure 9.4 Forces acting on propeller blades.

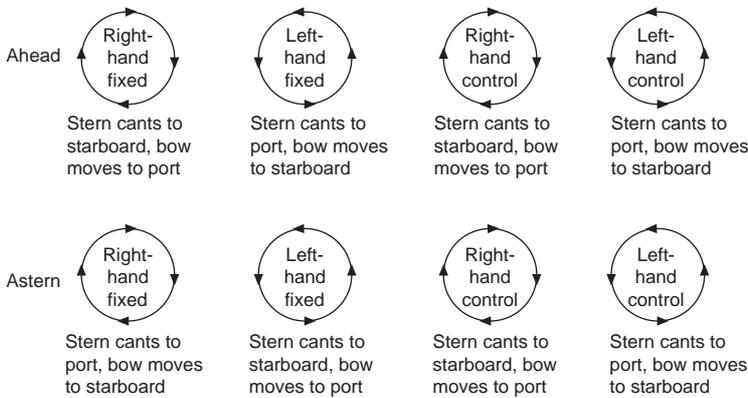


Figure 9.5 Propeller action when viewed from astern.

PROPELLERS

Right-hand Fixed Propeller

It is not within the scope of this text to discuss every type of propeller operational in present-day vessels. Some knowledge of the theory of the right-hand fixed propeller, however, should be sufficient for the reader to understand the properties of other propellers.

The marine propeller could be considered as something like a paddle wheel. Figure 9.4 shows the reaction and basic forces which affect the surface area of the propeller blades.

The resultant of the side components, caused by the rotation, may be resolved with the ahead motion created by the pitch angle of the blade. If the two forces are themselves resolved, then it would be seen that the stern of the vessel is moved to starboard. Consequently, if the stern is moved to starboard, then the bow may be seen to move to port. The opposite will happen when the vessel is moving astern, the only difference being that the side component will be resolved with a sternway motion and the result will be that the stern cants to port, with the bow going to starboard (see Figure 9.5).

Securing the propeller is shown in Figure 9.6.

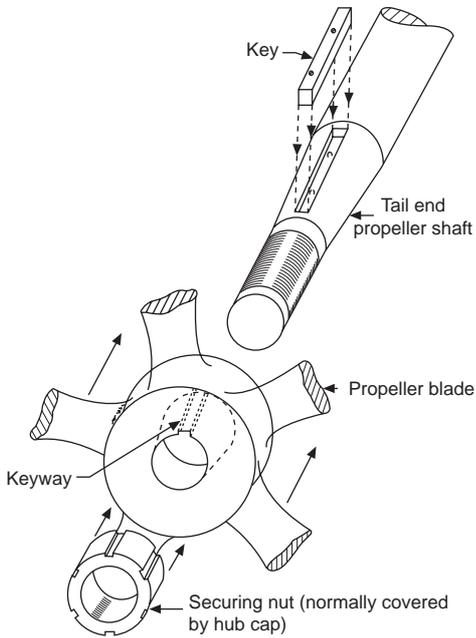


Figure 9.6 Method of securing conventional propeller.

Controllable Pitch Propeller

This is probably one of the most practical, and certainly most valuable, advances in the marine industry over the last 20 years (Figures 9.7 and 9.8). The advantages of the controllable pitch propeller over and above the conventional fixed propeller are as follows:

1. A reduction in fuel costs and consumption is achieved by the regular fixed turning speed of the shaft. The main machinery operates under optimum conditions per tonne of fuel burned.
2. Expensive diesel fuel is saved by the use of 'shaft alternators' linked to the constant speed rotating shaft. Auxiliary generators, though still carried, are not required for the normal loads that would be expected aboard a conventional vessel with a fixed propeller.
3. Should the propeller be damaged, spare propeller blades are carried and can be relatively easily fitted. Should only one blade be damaged, then the pitch of the propeller can be increased in order to return to port under the vessel's own power, though at a reduced speed.
4. A distinct ship-handling advantage is obtained by being able to stop in the water without having to stop main engines.
5. The need for compressors and for compressed air, for use in starting 'air bottles', is greatly reduced.
6. The watch officer gains more direct control over the vessel's speed for anti-collision purposes.

The advantages of the controllable pitch propeller system are now accepted, and one may wonder why more ships are not so fitted. The main reason is the very high cost of installation at the building stage, and the even higher cost of installing a CPP as a structural alteration to an existing vessel. A minimum shaft horsepower must also be present from the main machinery in order to obtain fuel economy and efficient running.

Manufacturers have accepted the needs of the industry by incorporating several features to improve the system.

Automatic disengaging of the propeller blades can now be achieved in some designs. This is especially desirable, for example, in small harbours, when the eddies from a constant rotating shaft may cause concern to small-boat owners or moored yachts near the stern.

Emergency over-ride controls may be included, and usually are, to enable the automation system to be by-passed and bring direct load on to the pitch actuator of the propeller.

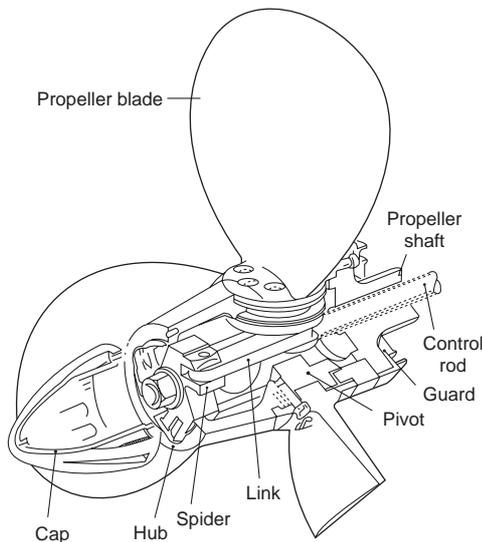


Figure 9.7 Controllable pitch propeller.

Twin-screw Single Rudder Vessels

Twin-screw vessels are normally designed with their propellers equidistant from the fore and aft line. Usually both are outward turning, the starboard propeller being right-hand-fixed and the port-propeller left-hand fixed. Many modern vessels are now constructed with twin controllable pitch propellers, especially fast ferries and the like.

The twin-screw vessel is usually easier and simpler to handle than the conventional single-screw vessel. The transverse thrust on a single screw

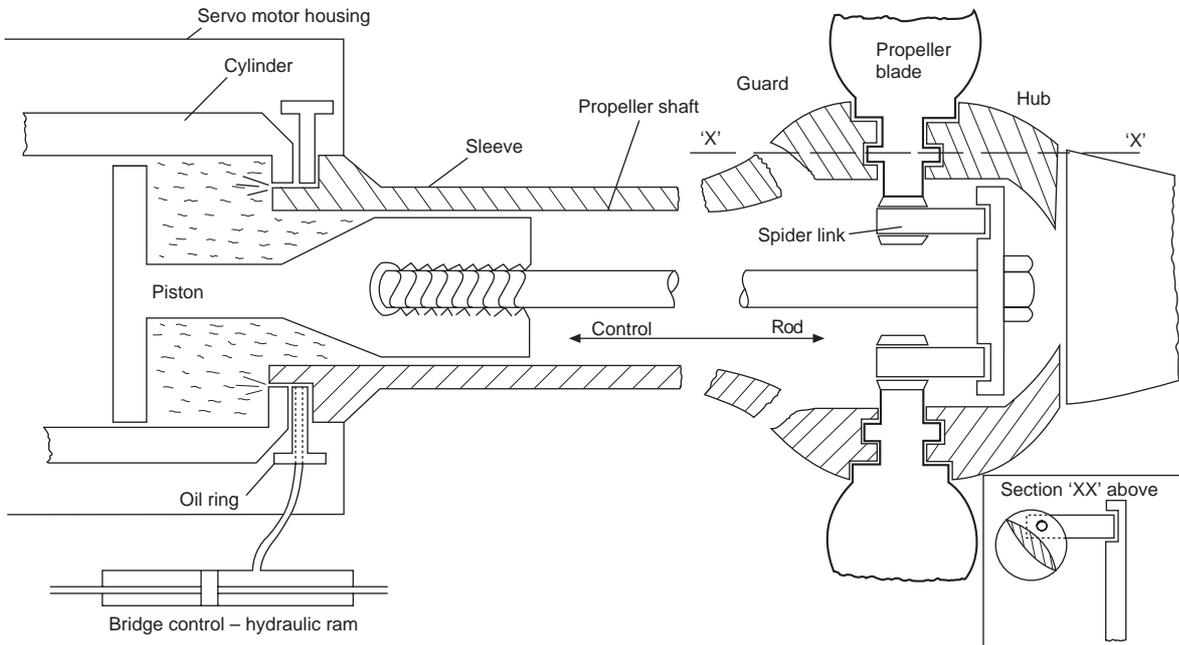


Figure 9.8 Controllable pitch propeller – working parts.

vessel strongly affects the steering capability, but with twin screws the forces tend to counteract each other, preventing the steering problems experienced by the single screw vessel (see Figure 9.9).

A distinct advantage of twin screws, apart from the increased speed created, is that if the steering gear breaks down, the vessel can still be steered by adjusting the engine revolutions on one or other of the propellers. When turning the vessel, for instance, one propeller can go ahead while the other is going astern (Figure 9.10).

Propeller Slip

When the vessel is moving ahead, the propeller exerts pressure on the water to create the forward motion. Propeller slip occurs because water is not a solid medium and there is some 'slip' related to it.

Slip may be considered as the difference between the speed of the vessel and the speed of the engine. It is always expressed as a percentage:

$$\text{Propeller slip} = \frac{\text{Actual forward speed}}{\text{Theoretical forward speed}} \text{ (per cent)}$$

The calculated value of slip will be increased when the wind and sea are ahead, and if the vessel has a fouled bottom. The differing values of slip are especially noticeable after a vessel has been cleaned in drydock.

Theoretically a vessel should never have a negative slip, but this may occur in one or more of the following conditions: a strong following sea, a following current or a strong following wind.

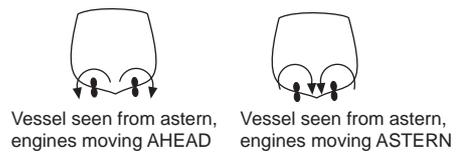


Figure 9.9 Twin-screw propulsion.

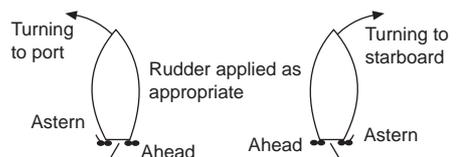


Figure 9.10 Steering by engines.

Example 1

During a 24-hour period of a voyage a ship's propeller shaft was observed to turn at 87 rpm. The pitch of the propeller was 3.8 m.

The observed ship's speed over the ground was 10 knots for the same 24-hour period. Calculate the value of the propeller slip during this period. (A nautical mile equals 1852 m.)

$$\text{Slip (per cent)} = \frac{\text{Engine distance} - \text{Ship's distance}}{\text{Engine distance}} \times 100$$

$$\text{Engine distance} = \frac{\text{Pitch} \times \text{rpm} \times 60 \times 24}{1852}$$

$$= \frac{3.8 \times 87 \times 60 \times 24}{1852}$$

$$= 257.054$$

$$\text{Ship's distance} = 24 \times 10$$

$$= 240$$

$$\text{Slip} = \frac{257.054 - 240}{257.054} \times 100$$

$$= \underline{\underline{+ 6.6 \text{ per cent}}}$$

Example 2

A propeller has a pitch of 4.5 m. The ship steams for a period of 18 hours at 115 rpm and then steams for a further 6 hours at the reduced speed of 100 rpm. After the full 24-hour period the logged distance indicates 330 miles but the log is known to have a 2 per cent negative slip. Calculate the propeller slip (A nautical mile equals 1852 m.)

$$\text{Propeller slip (per cent)} = \frac{\text{Engine distance} - \text{Ship's distance}}{\text{Engine distance}} \times 100$$

(From the log)

$$\text{Ship's distance} = \left(\frac{330}{100} \times 2 \right) + 330$$

$$= 336.6 \text{ nautical miles.}$$

$$\text{Engine distance} = \frac{4.5 \times 115 \times 18 \times 60}{1852} + \frac{4.5 \times 100 \times 6 \times 60}{1852}$$

$$= 301.8 + 85.33$$

$$= 387.13 \text{ nautical miles}$$

$$\text{Propeller slip} = \frac{387.1 - 336.6}{387.1} \times 100$$

$$= \frac{50.5}{387.1} \times 100$$

$$= \underline{\underline{+ 13.05 \text{ per cent}}}$$

TURNING CIRCLES

*General Definitions**Advance*

This is the forward motion of the ship from the moment that she starts the turn, i.e. the distance travelled by the vessel in the direction of the original course from starting the turn to completing the turn.

Diameters

The greatest diameter scribed by the vessel from starting the turn to completing the turn (ship's head through 180°) is the *tactical diameter*. The internal diameter of the turning circle where no allowance has been made for the decreasing curvature as experienced with the tactical diameter is the *final diameter*.

Transfer

This is defined by that distance which the vessel will move, perpendicular to the fore and aft line at the commencement of the turn. The total transverse movement lasts from the start of the turn to its completion, the defining limits being known as the transfer of the vessel when turning.

Advice for Helmsman and Officer of the Watch

1. A deeply laden vessel will experience little effect from wind or sea when turning, but a vessel in a light or ballasted condition will make considerable leeway, especially with strong winds.
2. When turning, the pivot point of the vessel is often situated well forward of the bridge and may produce the effect of the vessel turning at a faster rate than she actually is.
3. A vessel trimmed by the stern will steer more easily but the tactical diameter of the turn is increased.
4. A vessel trimmed by the head will decrease the diameter of the turning circle but will become difficult to steer.
5. If a vessel is carrying a list, the time taken to complete the turn will be subject to delay. A larger turn will be experienced when turning into the list.

Factors Affecting Turn

If the vessel is fitted with a right-hand fixed propeller, she would benefit from the transverse thrust effect, and her turning circle, in general, will be quicker and tighter when turning to port than to starboard. The following factors will affect the rate of turn and the size of turning circle:

1. Structural design and length of the vessel.
2. Draught and trim of vessel.
3. Size and motive power of main machinery.

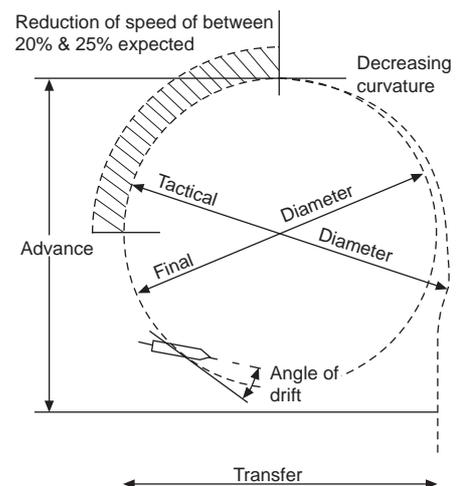


Figure 9.11 Turning circle.

27. New hull design has caused major changes to many marine aspects not least, ship handling and manoeuvring but also to rescue and survival recovery operations.



4. Distribution and stowage of cargo.
 5. Even keel or carrying a list.
 6. Position of turning in relation to the available depth of water.
 7. Amount of rudder angle required to complete the turn.
 8. External forces affecting the drift angle.
1. *Structural design and length.* The longer the ship generally, the greater the turning circle. The type of rudder and the resulting steering effect will decide the final diameter, with the clearance between rudder and hull having a major influence. The smaller the clearance between rudder and hull the more effective the turning action.
 2. *Draught and trim.* The deeper a vessel lies in the water, the more sluggish will be her response to the helm. On the other hand, the superstructure of a vessel in a light condition and shallow in draught is considerably influenced by the wind.

The trim of a vessel will influence the size of the turning circle in such a way that it will decrease if the vessel is trimmed by the head. However, vessels normally trim by the stern for better steerage and improved headway and it would be unusual for a vessel to be trimmed in normal circumstances by the head.
 3. *Motive power.* The relation between power and displacement will affect the turning circle performance of any vessel in the same way that a light speedboat has greater acceleration than a heavily laden ore carrier. It should be remembered that the rudder is only effective when there is a flow of water past it. The turning circle will therefore not increase by any considerable margin with an increase in speed, because the steering effect is increased over the same period. (The rudder steering effect will increase with the square of the flow of water past the rudder.)
 4. *Distribution and stowage of cargo.* Generally this will not affect the turning circle in any way, but the vessel will respond more readily if loads are stowed amidships instead of at the extremities. Merchant

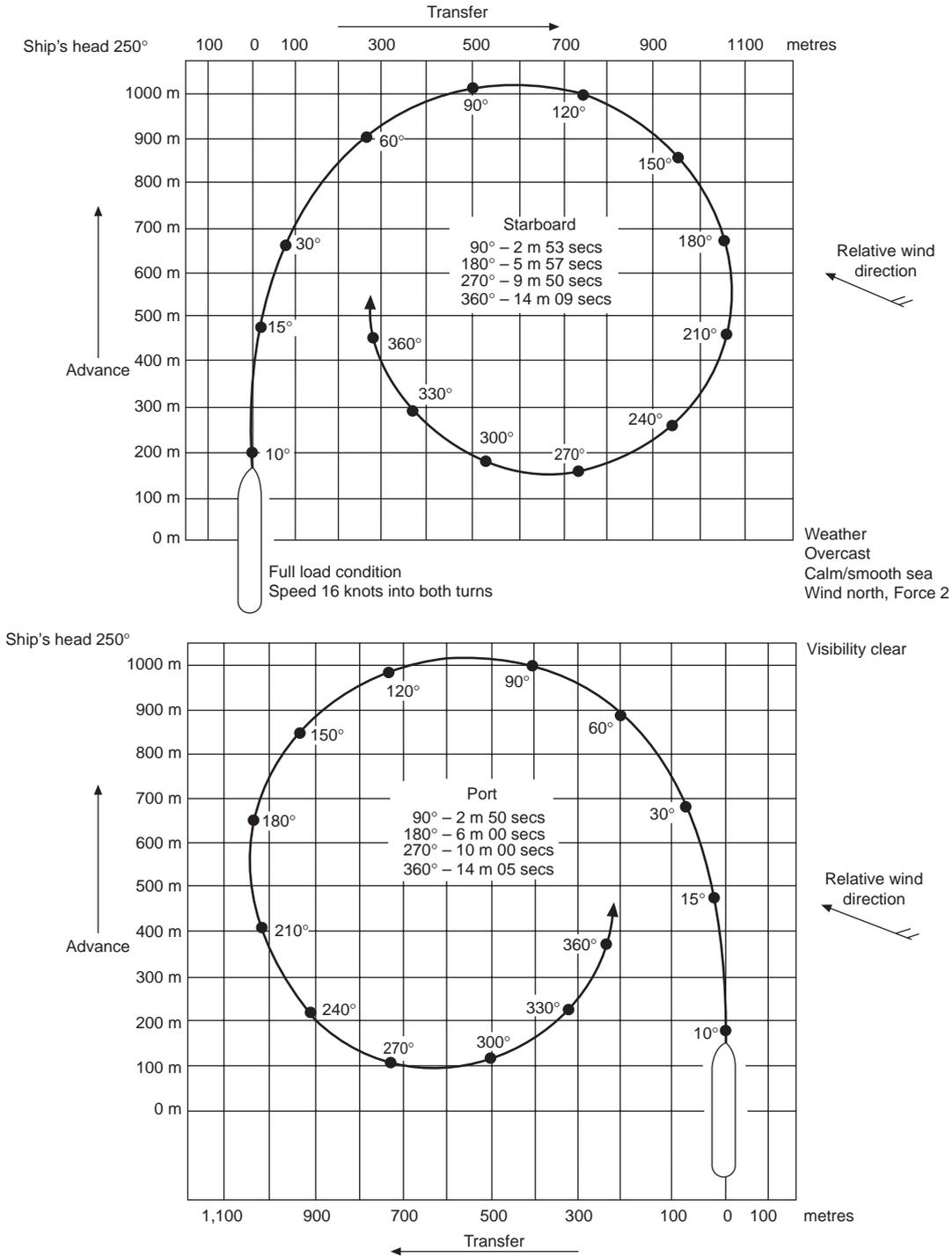


Figure 9.12 Turning circle of VLCC. Particulars of vessel: gross tonnage 133,035; net 108,853; dead weight 270,665; length OA 338.6 m; breadth 53.6 m; mould depth 26.4 m; load draught 20.6 m; main engine power 22,380 kW.

ship design tends to distribute weight throughout the vessel's length. The reader may be able to imagine a vessel loaded heavily fore and aft responding slowly and sluggishly to the helm.

5. *Even keel or listed over.* A new vessel when engaged on trials will be on an even keel when carrying out turning circles for recording the ship's data. This condition of even keel cannot, however, always be guaranteed once the vessel is commissioned and loaded. If a vessel is carrying a list, it can be expected to make a larger turning circle when turning towards the list, and vice-versa.
6. *Available depth of water.* The majority of vessels, depending on hull form, will experience greater resistance when navigating in shallow water. A form of interaction takes place between the hull and the sea bed which may result in the vessel yawing and becoming difficult to steer. She may take longer to respond to helm movement, probably increasing the advance of the turning circle, as well as increasing over the transfer. The corresponding final diameter will be increased retrospectively.
7. *Rudder angle.* Probably the most significant factor affecting the turning circle is the rudder angle. The optimum is one which will cause maximum turning effect without causing excessive drag.

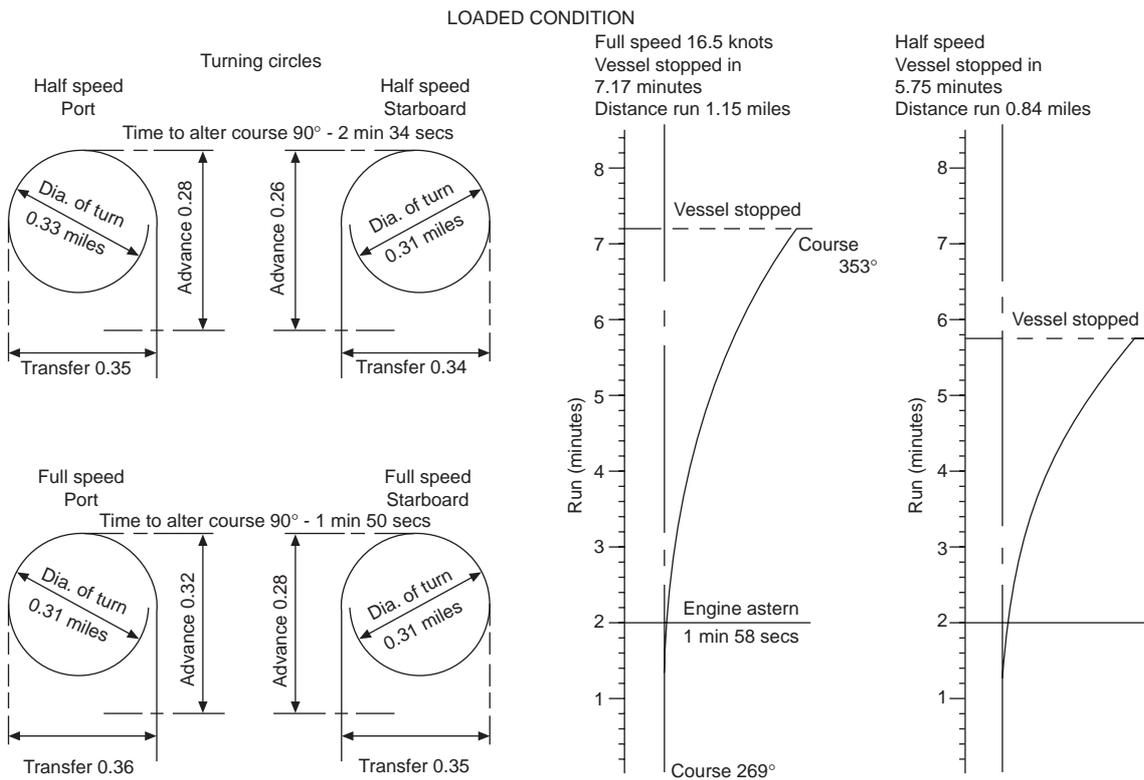


Figure 9.13 Turning circle of vessel with following particulars: gross tonnage 8243; net 4461; dead weight 13,548; 5 hatch general cargo; length OA 161 m; breadth 22.97 m; loaded draught 13.1 m; main engine power 8952 kW.

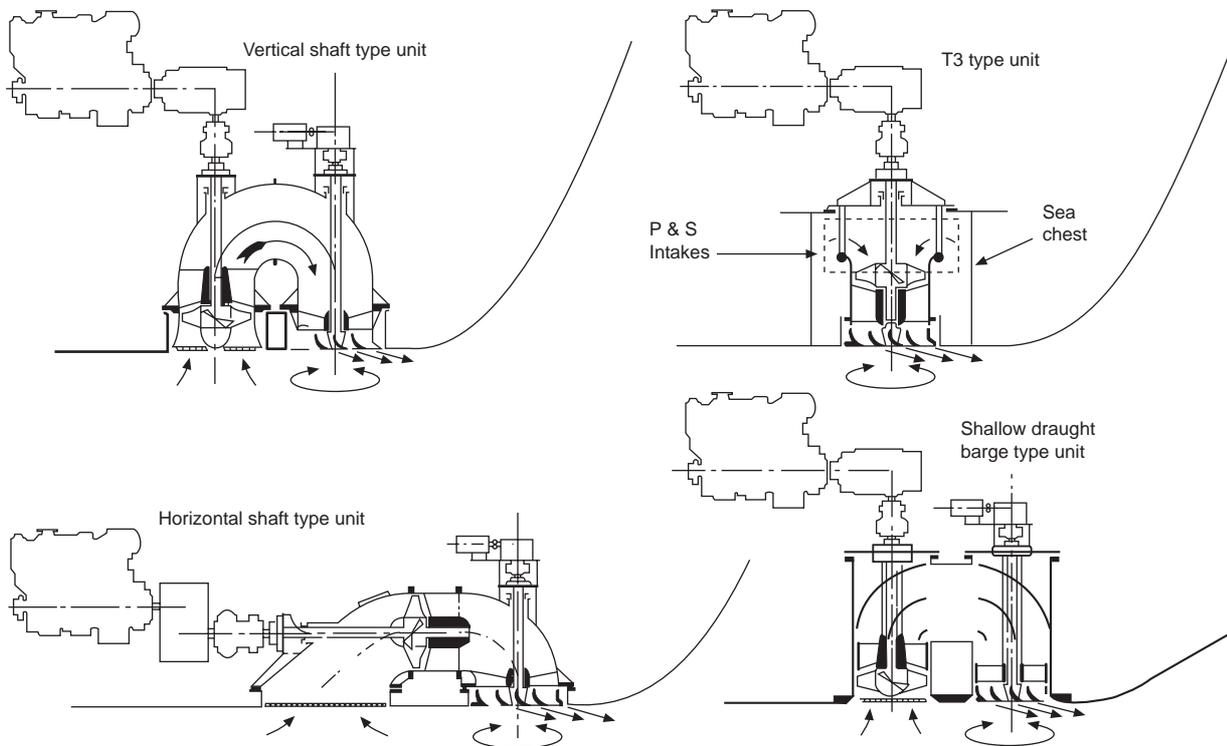


Figure 9.14 Elliott White Gill 360° thrust and propulsion units.

If a small rudder angle is employed, a large turning circle will result, with little loss of speed. However, when a large rudder angle is employed, then, although a tighter turning circle may be experienced, this will be accompanied by a loss of speed.

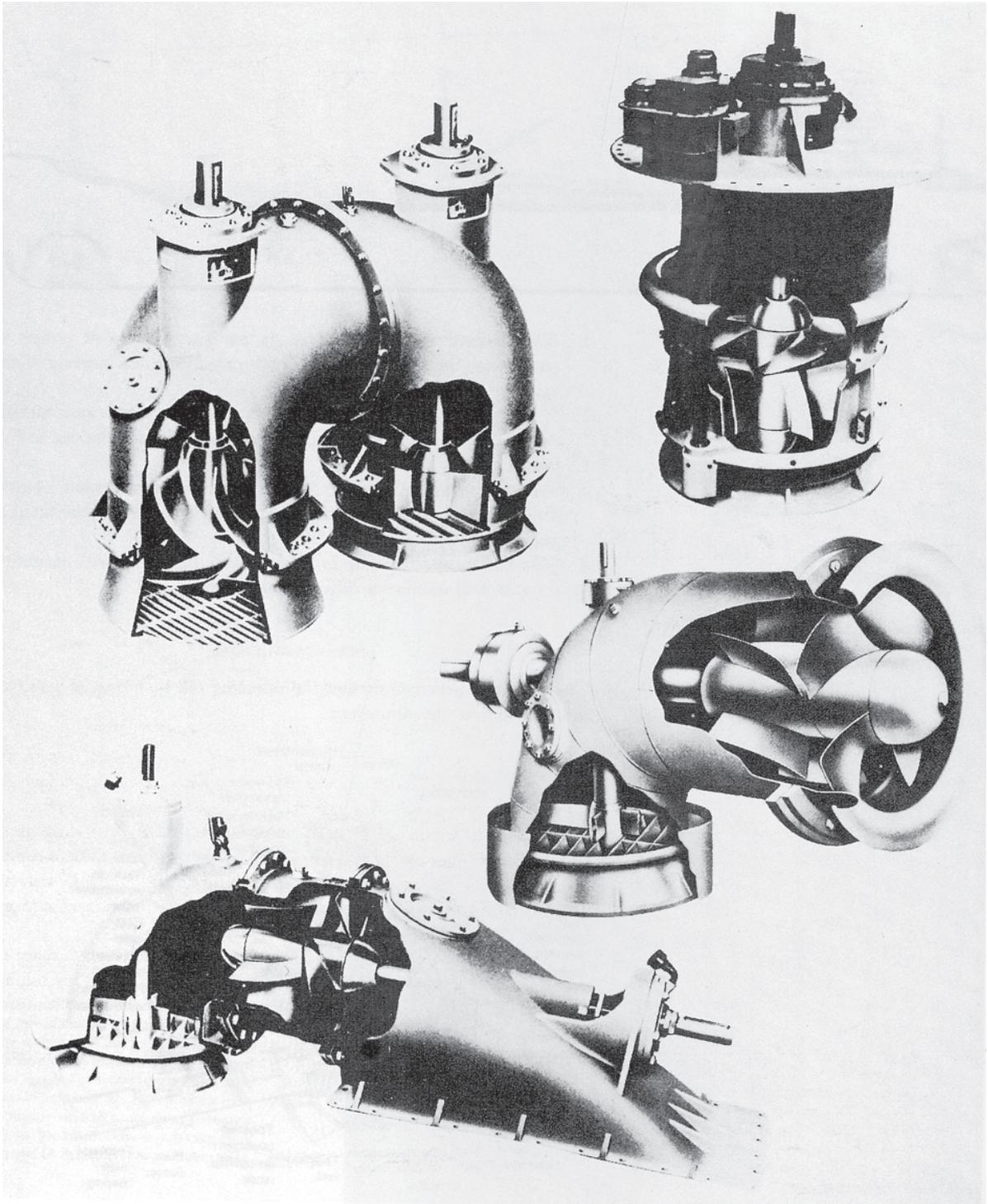
8. *Drift angle and influencing forces.* When a vessel responds to helm movement, it is normal for the stern of the vessel to traverse in opposing motion. Although the bow movement is what is desired, the resultant motion of the vessel is one of crabbing in a sideways direction, at an angle of drift.

When completing a turning circle, because of this angle of drift, the stern quarters are outside the turning circle area while the bow area is inside the turning circle. Studies have shown that the 'pivoting point' of the vessel in most cases describes the circumference of the turning circle.

BOW/STERN THRUSTER UNITS

Elliott White Gill 360° Thrust and Propulsion Units

Over the last twenty years thrust units have proved themselves in all aspects of ship-handling. Advances in design, power and control have all led to the development of bigger thrusters and better performance.



28. Bow thrust units as manufactured by Elliott Turbomachinery Ltd. These thrusters provide steering control without the use of rudders and main engines. Four models are available, capable of delivering thrusts of up to 17,000 kg. They are, shown clockwise from upper left, the Vertical Shaft, the T-3, the Cross Shaft and the Horizontal Shaft designs.

The Elliott White Gill 360° thruster unit (Figure 9.14) has some distinct advantages over the conventional 'tunnel thruster'. Not only can the force of the thrust be directed as the operator desires but with its location totally submerged all the time there is little chance of damage from surface obstructions.

The position of installation is so far beneath the water surface that the performance is not impaired by heavy weather. Pitching or heavy rolling have little or no effect as the intakes rarely break surface, if at all. Limited maintenance is required, with the unit being readily accessible from within the vessel. No part of the unit projects beyond the lines of the hull.

Bow thruster units are further illustrated in Plate 28.

Elliott White Gill 360° Trainable Thrust Units

The main ship-handling features of the 360° trainable thruster (Figure 9.15) are:

1. The thruster may be used as an auxiliary means of power or propulsion, being employed for both propulsion and steering of the vessel.
2. It is capable of turning a vessel in its own length and turning 'broadside' on without resorting to the use of main engines and/or rudder.
3. Remote control of thruster unit is achieved from a main control bridge panel. Additional bridge wing control panels may be fitted as required.
4. The thrust capacity of up to 17 tonnes can hold the vessel on station even in bad weather or heavy sea conditions.

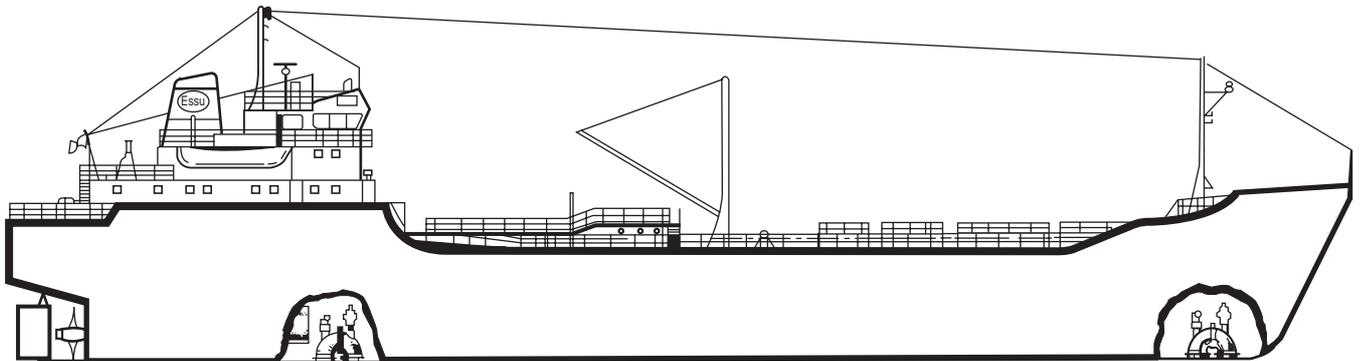


Figure 9.15 Elliott White Gill 360° trainable thrust units.

FIN STABILISERS

There are two principal methods of reducing roll by means of stabilisation available to the shipowner:

- (a) Active fin – folding (Figures 9.16 and 9.17) or retractable type.
- (b) Free surface tanks.

position, then a free surface tank system may be better suited for the nature of work.

MANOEUVRING WITH MOORING LINES

The main function of mooring lines, be they wire or fibre ropes, is to retain the vessel in position. However, there are times when they may be used in the turning or manoeuvring of the vessel, as when entering a dock or coming off quays (see Figures 9.18 and 9.19).

FAIRLEADS

The roller fairlead is often encountered as a double or even treble lead, but is also found as a single lead on a stand or pedestal (Figure 9.20). It is in common use aboard a great many modern vessels, where it is generally referred too as an 'old man' or a 'dead man' because of its static pose. It has proved its usefulness in mooring operations for altering the lead of a rope or wire through very sharp angles.

Maintenance should be on a regular basis with regard to greasing and oiling about the axis. The pedestal should be painted at regular intervals to prevent corrosion. Should a lead of this type become seized it is normal to soak the moving parts in release oil and then attempt to free the roller lead by use of a mooring rope to the warping drum end, so creating a friction drive.

Universal Multi-angled Fairlead

This fairlead (Figure 9.21) consists of two pairs of axial bearing rollers, one pair in the vertical plane and the other pair in the horizontal. The main advantage of this type of lead is that it provides a very wide angular range not only in the horizontal and vertical planes but also in any oblique plane.

The main disadvantage of the lead is that it requires regular maintenance in the way of periodic greasing through grease nipples at each end of the rollers. When compared with the panama lead, the rollers respond when mooring lines are under tension, so that friction is reduced, whereas the panama lead has no moving parts and friction may cause limited damage.

Universal leads are regularly found on the quarter and shoulder areas of the vessel for the multiple use of spring or head and stern lines.

Panama Lead

This type of lead is very common aboard modern vessels.

It may be a free standing lead, as shown in Figure 9.22, in which case the underdeck area is strengthened, or it may be set into bulwarks and strengthened by a doubling plate. The lead is one favoured by seafarers because the rope or wire cannot jump accidentally when under weight.

BOLLARDS (BITTS)

The term 'bollard' is usually applied to a mooring post found on the quayside and 'bitts' to the twin posts found on ships (Figure 9.23).

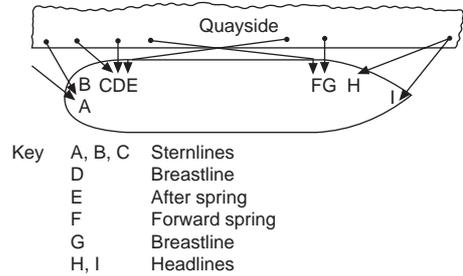


Figure 9.18 Example of moorings used to secure vessel to quay.

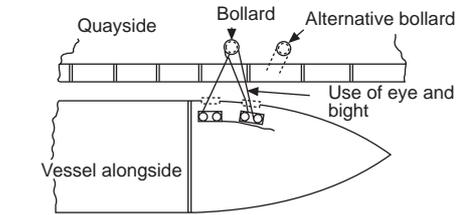
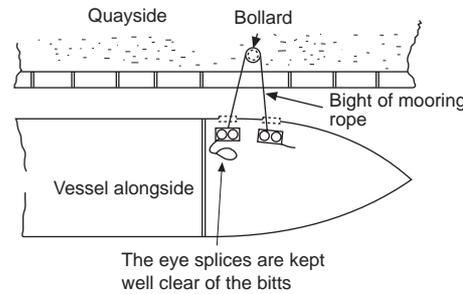


Figure 9.19 Mooring rope used as a bight (above) and as an eye and a bight (below).

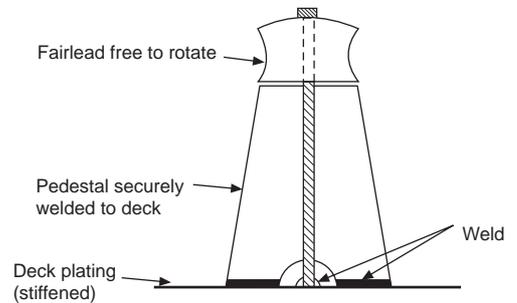


Figure 9.20 Roller fairlead.

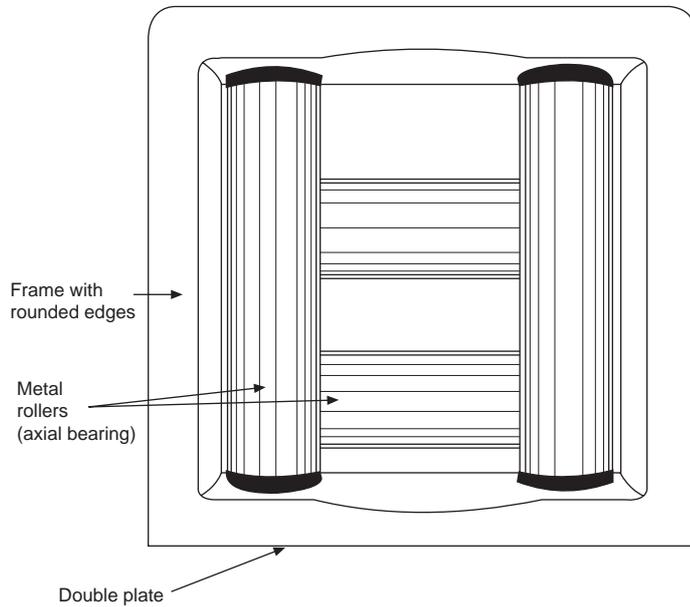


Figure 9.21 Universal multi-angled fairlead.

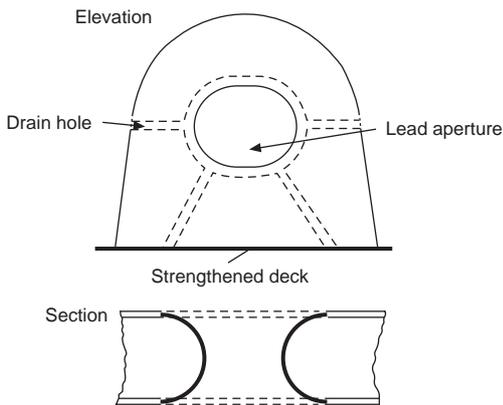


Figure 9.22 Panama lead.

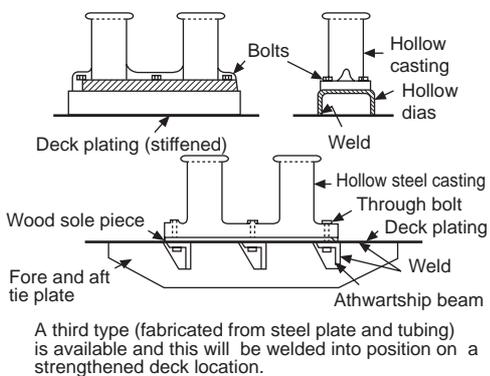


Figure 9.23 Bollards and bitts.

RIGGING SLIP WIRES OR ROPES

The purpose of the slip wire is to enable the vessel to let herself go, at any time, without being dependent on the port's linesmen to clear lines from bollards. It is generally always the last line to let go. In some circumstances a slip rope may be used (see Figure 9.24).

Slip wires tend to run easily when letting go and heaving taut, but the wire is heavy and often difficult to handle. A strong messenger must be employed to heave the eye back aboard when rigging, because the wire will not float as a rope may, and there may be a long drift between the bow or stern and the bollard buoy.

Slip ropes are easier to handle and manipulate through the ring of a mooring buoy, but they are bulky and slow in running because of surface friction between the rope and buoy ring. They generally float on the surface when going out to the buoy and when being heaved back aboard, this fact considerably reduces the weight on the messenger.

Whether a wire or rope is to be used, a prudent seaman will always seize the eye of the slip to allow clear passage through the ring of a mooring buoy.

Operation

Arrange the slip wire in long flakes down the deck length, then pass the eye down into the mooring boat. Additional slack on the wire should be given to the boat and coiled down on the boat's bottom boards. This provides the boat handler with slack to ease the weight, should the slip become snagged aboard. Pass a messenger into the mooring boat with the slip wire, but do not make the messenger fast to the slip wire at this stage.

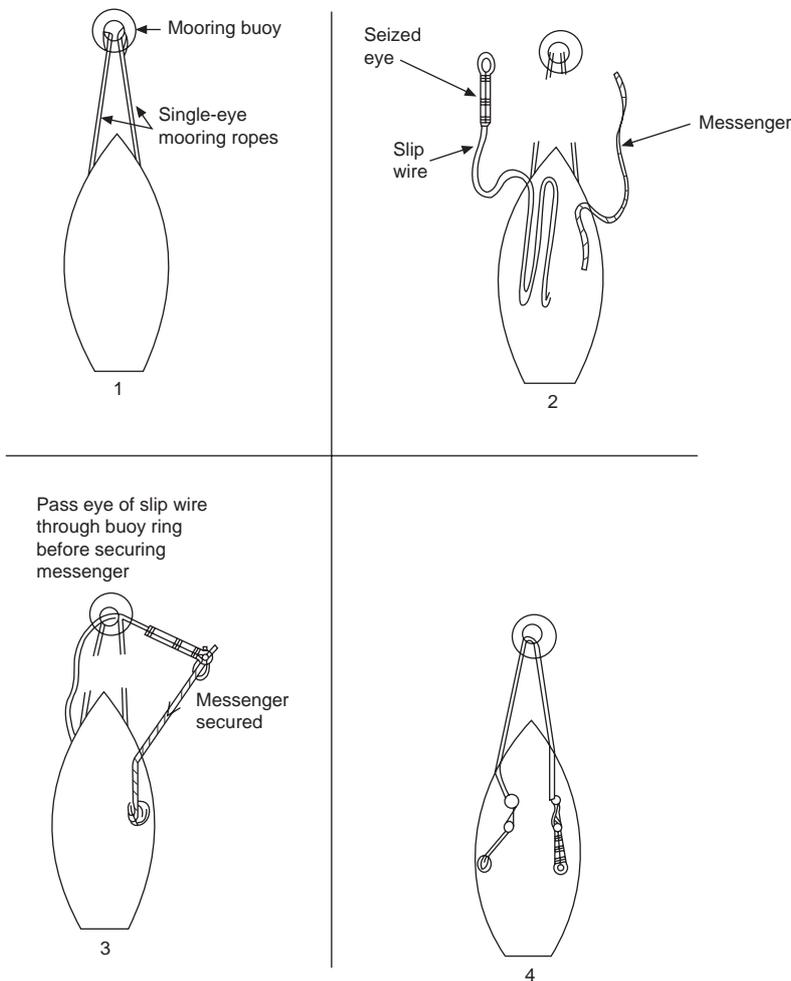


Figure 9.24 Rigging of slip wires.

A port mooring boat will be required for this operation, together with a lifejacket for the man engaged in buoy jumping and dipping the lines through the ring of the buoy.

1. Secure the forward or after end to the buoy in order to steady the vessel before passing the slip wire.
2. Prepare the slip wire beforehand by seizing the eye of the wire to enable it to pass through the ring of the buoy. Flake a messenger to the mooring boat with the slip.
3. Dip the slip wire through the ring of the buoy and secure the messenger to it. Once the small boat is clear, signal the vessel to heave the slip wire aboard, via the messenger.
4. Once the slip wire is aboard, release the messenger and turn up the slip wire on the bollards. Do not place eyes over bits, as this may restrict letting go when weight is on the wire.

As the mooring boat travels towards the buoy, pay out both slip wire and messenger. A man wearing a lifejacket should then 'jump the buoy', pass the seized end of the slip through the ring, then secure the messenger to the small part of the eye of the slip wire. The messenger should never be passed through the ring of the buoy first, for this may cause the hitch to jam in the ring of the buoy when heaving back aboard. Signal to the officer in charge aboard the vessel to heave away on the messenger and bring the slip wire back aboard. Detach the messenger and turn up both parts of the slip wire in 'figure eights' on the bits. Do not put the eyes of the slip on the bits, as this would make letting go difficult if weight is on the wire.

BERTHING

Let us assume that no tugs are available and that the ship has a right-hand fixed propeller (see Figures 9.25 and 9.26).

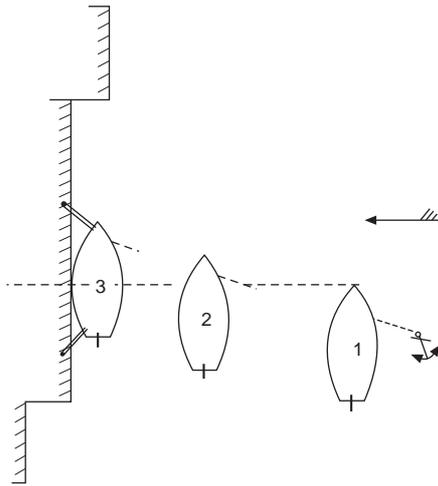


Figure 9.25 Berthing, wind onshore, tidal conditions calm.

1. Stop the vessel over the ground in a position with the ship's bow approximately level with the middle of the berth. Let go offshore anchor.
2. Control the rate of approach of the vessel towards the berth by ahead movements on main engines, checking and easing out anchor cable as required. Try and keep the vessel parallel to the berth.
3. Check cable within heaving line distance of the berth. Make fast fore and aft. Slack down cable when alongside.

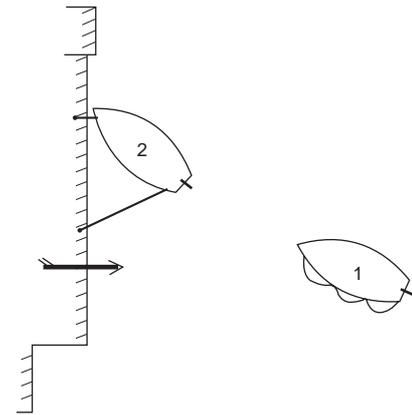


Figure 9.26 Berthing, wind offshore, tidal conditions calm.

1. Approach berth at a wide angle to reduce wind effect and prevent the bow from paying off.
2. Slowly approach berth and maintain position over ground.
3. Pass head line and stern line together from the bow area.
4. Stay dead slow astern on main engines, ease head line and at the same time take up the weight and any slack on the stern line. Draw the vessel alongside and secure. Depending on the strength of the wind, it would be advisable to secure a breast line forward as well as additional lines fore and aft as soon as practicable.

CLEARING A BERTH

Let us assume that no tugs are available and that the ship has a right-hand fixed propeller (see Figures 9.27 to 9.30).

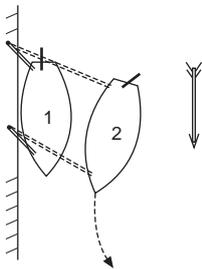


Figure 9.27(a) Clearing a berth, wind and tide astern.

1. Single up to stern line and forward spring.
2. Main engine astern, ease out on stern line until stern is well clear of quay.
3. Let go and take in stern line. Let go forward.
4. When well clear of quay, stop main engine. Put rudder to port, and go ahead on main engine.

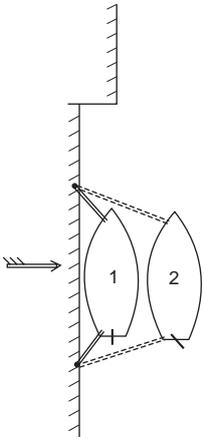


Figure 9.27(b) Clearing a berth, no tugs available, right-hand fixed propeller.

1. Single up to a head line and stern line.
2. Let vessel blow off the quay: keeping the vessel parallel to the quay by checking and controlling lines forward and aft.
3. When clear of the quay, let go fore and aft lines. Half ahead followed by full ahead on main engines if circumstances permit. Rudder applied as appropriate.

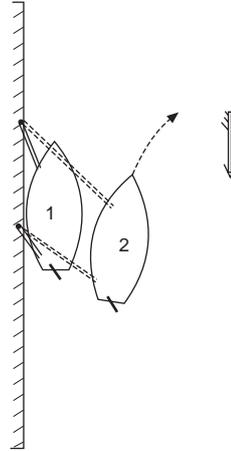


Figure 9.28 Clearing a berth, wind and tide ahead.

1. Single up to a head line and aft spring.
2. Ease away head line, rudder to starboard. With the tidal effect between the bow and the quayside the ship's bow should pay off.
3. Ease out on head line, slow ahead on main engines, take in head line and pick up slack on aft spring. Let go and take in aft spring. Use engine and rudder as appropriate.

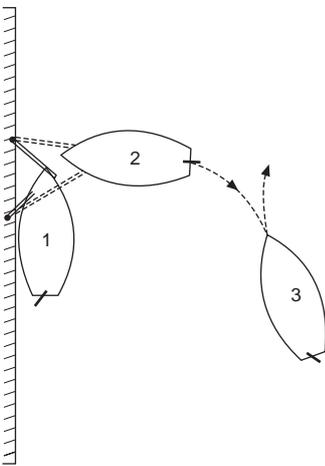


Figure 9.29 Clearing a berth, port side to, no wind or tide.

1. Single up forward to an offshore head line and forward spring.
2. Keeping the weight on the forward spring, heave on the head line in order to cant the stern away from the quay wall. The stern will make a more acute angle with the quay if the main engine is ordered 'dead' slow ahead and the rudder put hard to port. Care should be taken to avoid putting the stem against the quay wall, especially if the vessel is of a 'soft nose' construction. Let go in the forepart.
3. Put main engines astern and allow the vessel to gather sternway to clear berth.

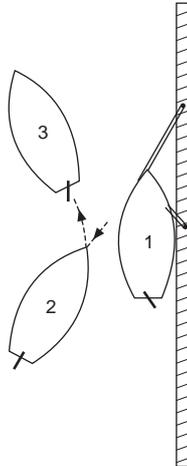
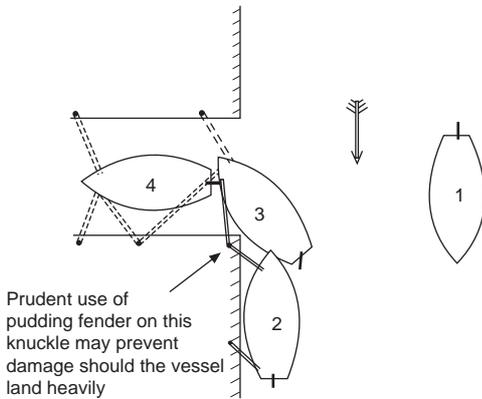


Figure 9.30 Clearing a berth, starboard side to, no wind or tide.

1. Single up forward to an offshore head line and forward spring.
2. Heave on the head line to bring the stern away from the quay wall. It may be necessary to double up the forward spring with the intention of using an ahead engine movement, allowing the spring to take the full weight, and effectively throwing the stern out from the quay. Let go smartly forward, main engines astern. When vessel gathers sternway, stop.
3. When clear forward, put rudder hard aport, and main engine full ahead.

ENTERING DOCK



No tugs are available and the ship has a right-hand fixed propeller (see Figure 9.31).

Figure 9.31 Entering dock, wind and tide astern.

1. The vessel should turn 'short round' (Figure 9.38) or snub round with use of starboard anchor. The ship will then be in a position of stemming the wind and tide and should manoeuvre to land 'port side to' alongside the berth below the dock.
2. Secure the vessel by head lines and aft spring to counter tide effect and keep her alongside.
3. Put main engines slow ahead to bring the 'knuckle' of the dock entrance midships on the vessel's port side. Pass a second head line from the starboard bow across the dock entrance to the far side. Take the weight on this head line. Let go aft spring. As the vessel comes up to the knuckle, ease the port head line until the ship's head is in the lock, then heave on the port head line to bring ship parallel to sides of lock.
4. Carry up head lines alternately from each bow. Send out stern line and forward spring once the vessel is inside the dock. Stop main engines and check ahead motion as appropriate.

SECURING TO BUOYS

No tugs are available and the ship has a right-hand fixed propeller (see Figures 9.32 to 9.35).

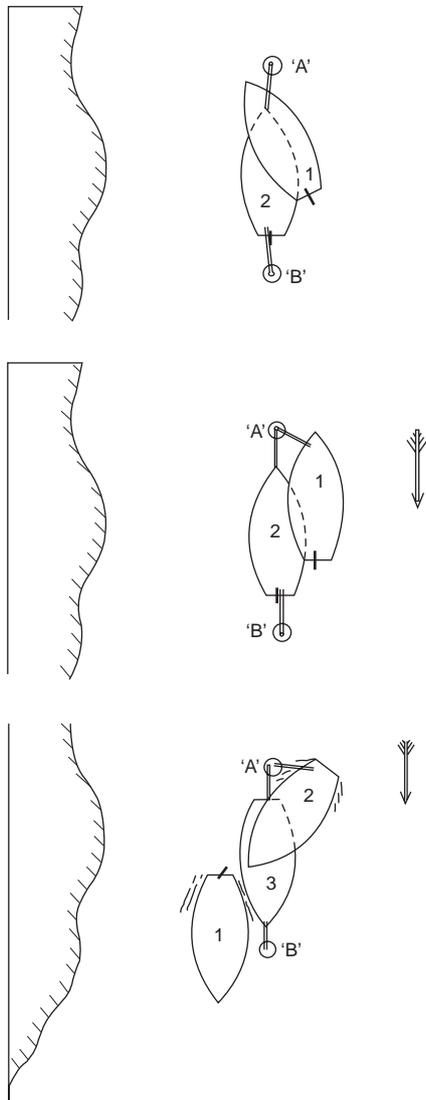


Figure 9.32 Securing to buoys, no wind or tide.

1. Approach the buoy 'A' slowly, with the buoy at a fine angle on the starboard bow, to allow for transverse thrust when going astern.
2. Stop the vessel over the ground and pass head and then stern lines. Align vessel between buoys 'A' and 'B' by use of moorings, and secure fore and aft.

Figure 9.33 Securing to buoys, wind and tide ahead.

1. The vessel should stem the tide and manoeuvre to a position with buoy 'A' just off the port bow. It may be necessary for the vessel to turn short round or snub round on an anchor before stemming the tide. Adjust main engine speed so that the vessel stops over the ground. Pass head line.
2. Although an astern movement of main engines would cause the bow to move to port, if required, holding on to the head line would achieve the same objective, by allowing the tide/current to effect the desired movement from position '1' to position '2'. Pass stern line once vessel is aligned between the two buoys 'A' and 'B'.

Figure 9.34 Securing to buoys, wind and tide astern.

1. Vessel under sternway, stern of the vessel seeking the eye of the wind. Use of rudder may assist to bring buoy 'A' on to the starboard quarter.
2. Run stern line from starboard quarter and make fast.
3. The vessel could expect to be moved by wind and tide to a position between the two buoys. The vessel may then be secured forward by head lines to buoy 'B'.
4. The success of this manoeuvre will, of course, depend on the strength of wind and tide. It might be necessary to turn the ship around to stem wind and tide, or, if the ship is to lie in the direction shown, it might be necessary to turn the ship and secure the bow to the other buoy shown and allow her to swing with the change of tide.

Care should be taken that any stern lines are kept clear of the propeller when the vessel is navigating stern first.

MOORING

The term mooring is used in conjunction with the securing of the vessel, either by two anchors or to a mooring buoy. The term is often used when vessels are moored to a jetty or quay by means of mooring ropes (Plate 29). The term may be considered, therefore, to be rather a loose one, applying to several methods of securing a ship. Most seafarers consider it to mean 'mooring with two anchors', in the form of a running moor, standing moor or open moor.

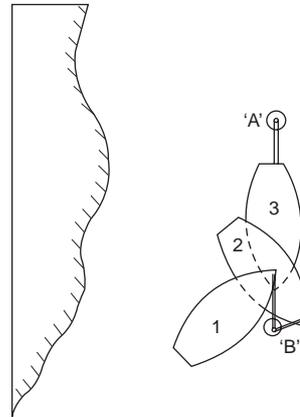


Figure 9.35 Securing to buoys, no wind or tide.

1. Approach buoy 'B' at a fine angle on the starboard bow. Pass head line and overrun the buoy about a third of the vessel's length from the bow. Hold on to the head line to check the vessel's headway. Allow the head line to act as a spring.
2. Rudder hard a-starboard, main engines ahead to turn the vessel about buoy 'B'.
3. Astern movement on engines will cause the port quarter to close towards buoy 'A'. This motion will further be assisted by the transverse thrust effect of the propeller. When the vessel is aligned between buoys, secure fore and aft.

LETTING GO FROM BUOYS

No tugs are available and the ship has a right-hand fixed propeller (see Figures 9.36 and 9.37).

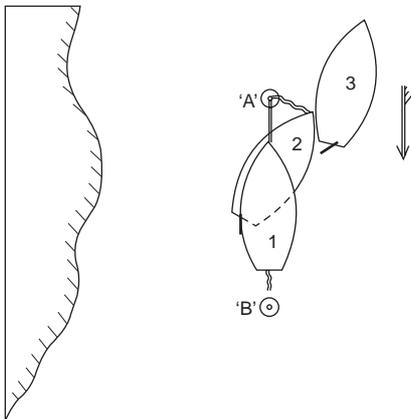


Figure 9.36 Letting go from buoys wind and tide ahead.

1. Let go stern line from buoy 'B'. When clear aft, apply starboard helm and go dead slow ahead on main engines.
2. As the vessel's bow moves to starboard, ease the head line. When clear of buoy 'A', let the head line go forward.
3. Main engines ahead, port rudder.

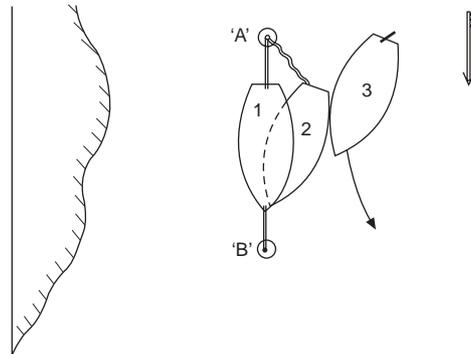


Figure 9.37 Letting go from buoys, wind and tide astern.

1. Slack stern line to see if the vessel will 'cant' away from buoy 'A'.
 2. If the vessel cants, let go head line, with main engines half astern. Port helm and allow vessel to gather sternway.
 3. When the vessel clears buoy 'A', let go stern line. Main engines ahead once stern line is clear of propeller, helm hard a-port.
- If the vessel will not 'cant', let go the head line and heave the vessel close up to buoy 'A'; put rudder hard a-port, let go aft, with main engines full ahead.
- Once headway is gathered, make sharp helm movement to hard a-starboard to throw the stern clear of the buoy.

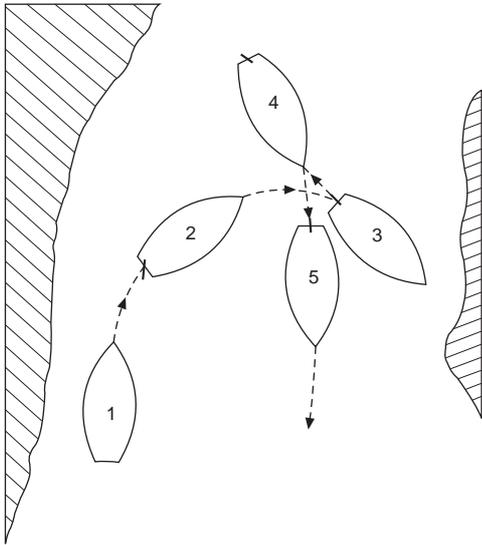


Figure 9.38 Turning a vessel short round.

The vessel is equipped with a right-hand fixed propeller, and, when turning 'short round', she would turn more easily to starboard than to port.

1. Start the manoeuvre from the port side of the channel to provide the maximum distance for the headreach movement of the vessel.
2. Rudder hard a-starboard, main engines full ahead. Stop engines. Do not allow the vessel to gather too much headway.
3. Rudder midships, main engines full astern.
4. As sternway is gathered, the bow of the vessel will cant to starboard while the port quarter will move in opposition, owing to the effects of the transverse thrust. Stop engines.
5. Rudder to starboard, engines ahead.

29. Vessel moored alongside a quay, secured by two head lines and a rope spring led aft from the starboard shoulder. The port anchor, having been let go during the berthing operation, has been left with the cable in the 'up and down' position for the purpose of heaving the vessel off the berth when letting go. Panama leads are clearly visible, one of them a centre lead. Triple roller fairleads are to be seen on either bow.

TURNING VESSEL SHORT ROUND

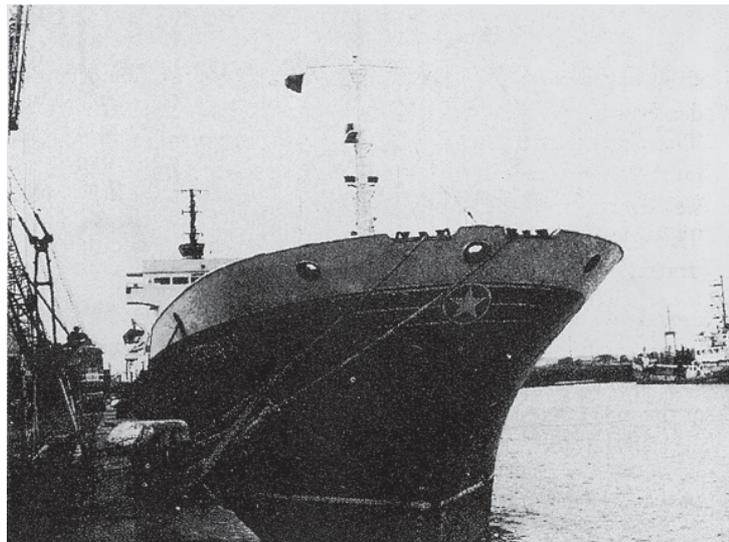
The ship has a right-hand fixed propeller (see Figure 9.38).

Running Moor

In all ship-handling situations the vessel should stem the tide if control is to be maintained. The running moor operation (Figure 9.39) is no exception to this rule, and should the tidal stream be astern of the vessel, then she should be manoeuvred to stem the tide, either by turning short round or snubbing round on an anchor. This will not always be possible however, and the running moor may have to be made with the tide. A running moor procedure is as follows:

1. Speed over the ground should be 4–5 knots, preferred depth of water being dependent on draught, and good holding ground chosen if possible. Let go the weather anchor, so that the vessel will be blown down from the anchor cable before she reaches the desired position.
2. Continue to make headway, paying out the cable of the anchor which has been let go. Continue to pay out the cable up to eight or nine shackles, depending on the amount of cable carried aboard and the depth of water. The vessel will overrun the desired mooring position.
3. The vessel should start to drop astern as the engines are stopped. Let go the lee anchor and pay out the cable. Start heaving away on the weather anchor cable to bring the vessel up between the two anchors. The vessel may require an astern movement on the engines to begin drawing astern.

In comparison with the standing moor the ship's machinery is running and operational throughout the manoeuvre. In the standing moor the vessel's machinery could well be out of action, standing still, while the vessel drops astern with the tidal stream.



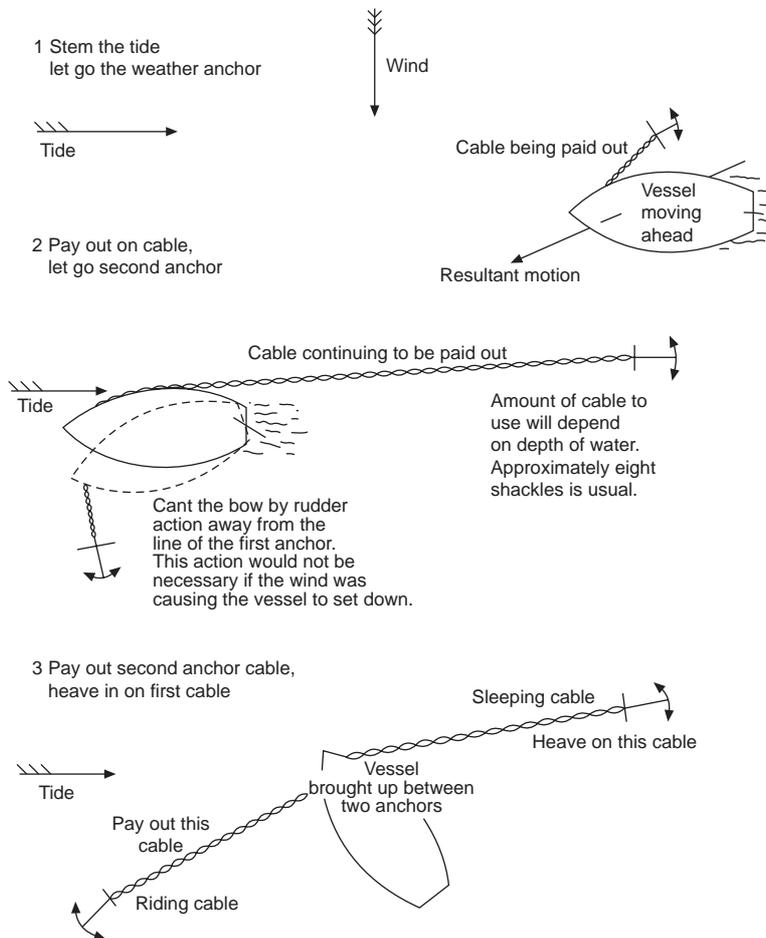


Figure 9.39 Running moor.

Standing Moor

The vessel must stem the tide, in order to retain control of the operation (Figure 9.40), which proceeds as follows:

1. The vessel should be head to tide, stopped over the ground. Sternway should be gathered either by the tidal stream or operating astern propulsion. Let go the lee anchor (riding cable) and allow the vessel to drop astern. Pay out the anchor cable as sternway is gathered, up to 8–9 shackles, depending on the amount of cable carried aboard and the depth of water.
2. Take the sternway off the vessel by use of engines ahead and checking on the weight of the cable. Order maximum helm away from the released anchor, and engines ahead to cant the vessel before letting go the weather anchor (sleeping cable). The mariner should continue to use engines ahead or astern as necessary to ease the weight on the windlass as the vessel heaves on the riding cable.

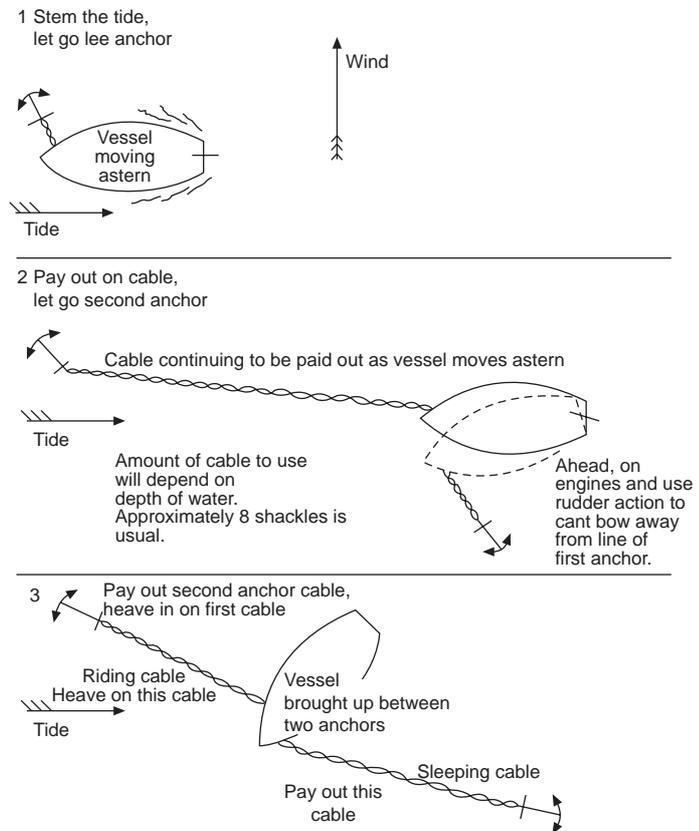


Figure 9.40 Standing moor.

- Continue to heave on the riding cable and pay out the sleeping cable until the vessel is brought up between the two anchors.

A standing moor is sometimes preferred to a running moor when the tidal stream is very strong. The standing moor in theory could be carried out by just allowing the tidal stream and the windlass to do the work.

The main danger of mooring with two anchors is the possibility of causing a foul hawse when the vessel swings with the turn of the tide. To reduce this most undesirable condition the Royal Navy tends to use a mooring swivel, joining the two cables. Merchant vessels would not generally carry such a swivel, unless it is intended to secure the vessel to a semi-permanent mooring over an indefinite period of time.

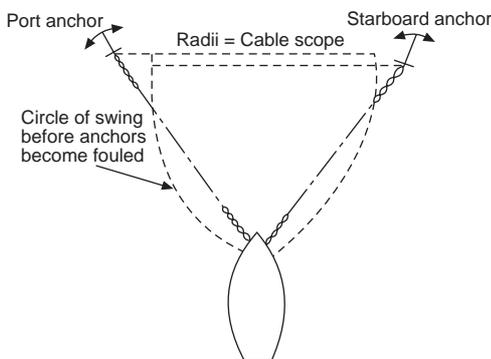


Figure 9.41 Open moor.

OPEN MOOR

The open moor (Figure 9.41) is used extensively when additional holding power is required. It would be employed when a single anchor would not provide enough weight to hold the vessel and prevent the ship from dragging.

Possibly the best method of approach is to stem the current and/or head the wind, and position the vessel to let go the windward anchor.

Once this first anchor has been 'let go' pay out on the cable with simultaneous 'ahead movements on engines' to manoeuvre the vessel towards a position of letting go the second anchor. Extensive use of rudder and engines may be required to achieve this second desired position.

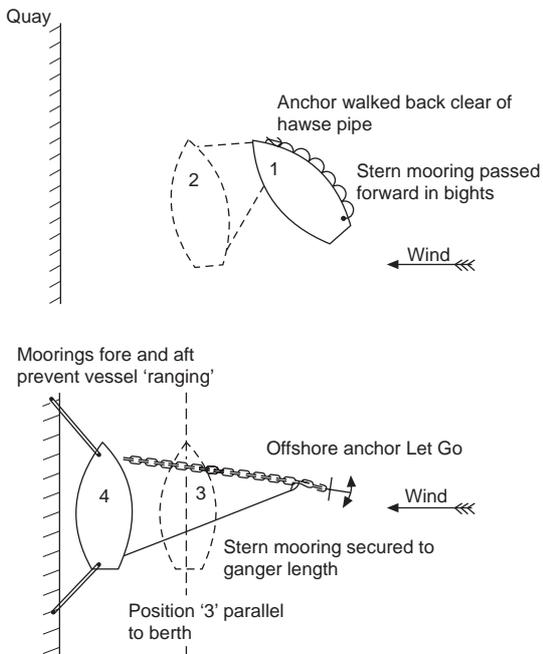
Once the second position is attained, let go the second anchor, order astern movement of the engines, and pay out on the second anchor cable. The first anchor cable will act as a check until both cables have an even scope, once this situation is achieved then cables can be payed out together as required to obtain the final position of mooring.

Masters should bear in mind that with this method, the first anchor may be turned out of the holding ground when the vessel gathers sternway after the second anchor has been released. To this end it may become prudent to check both cables prior to coming to rest, so ensuring that both the second and the first anchors are bedded in and holding.

Baltic Moor

The vessel should approach the berth with the wind on the beam or slightly abaft the beam. The stern mooring wire should be secured in bights by light seizings in the forward direction to join the ganger length of the anchor cable before the approach is begun. Then proceed as follows:

1. Manoeuvre the vessel to a distance off the berth of two or three shackles of cable. This distance will vary with the wind force and expected weather conditions.



30. Cruise ship moored, deploying both Port and Starboard anchors. N.B. Additional centre anchor in stowed position.

Figure 9.42 Baltic moor.

2. Let go the offshore (starboard) anchor. The weight of the anchor and cable will cause the sail twine securing on the mooring wire to part, and as the cable pays out, so will the stern mooring wire.
3. Let the wind push the vessel alongside, while you pay out the cable and the stern wire evenly together.
4. Use ship's fenders along the inshore side between the vessel and the quay, then pass head and stern lines as soon as practical.
5. Secure head and stern lines on the bitts before taking the weight on the anchor cable and the stern mooring wire. This tends to harden up the inshore (port) moorings.

One reason behind the Baltic moor is that many ports experience strong Onshore winds.

When the vessel comes to let go and depart the port, unless she is fitted with bow thrust units, the Master may encounter difficulties in clearing the berth. However, heaving on the anchor cable and on the stern mooring will allow the vessel to be bodily drawn off the quay. Once clear of the berth, full use can be made of engines and helm to get under way.

The main disadvantage of this moor is that time is required to let the stern mooring go from anchor/cable. To this end the size of shackle used and the possibility of allowing it to pass up the hawse pipe are critical factors. Alternatives are to find a lee for the vessel for the purpose of disengaging the stern mooring.

Mediterranean Moor

This moor is carried out usually for one of two reasons – either quay space is restricted and several vessels are required to secure or a stern loading/discharge is required. (As for a tanker.) The object of the manoeuvre is to position the vessel stern to the quay with both anchors out in the form of an open moor. The stern of the vessel is secured by hawsers from the ship's quarters to the quay.

This type of mooring (Figure 9.43) is not unusual for tankers using a stern load or discharge system. However, a disadvantage to the dry cargo vessel lies in the fact that cargo must be discharged into barges. It is not a favourable position in bad weather and there is a distinct possibility of fouling anchor cables, especially when other vessels are moored in a similar manner close by. The procedure is as follows:

1. Approach the berth, as near parallel as possible to the quay. Let go the offshore anchor. Main engines should be ahead and dead slow.
2. Rudder should be positioned hard over to turn the vessel away from the quay. Continue to let the cable run, and pay out as the vessel moves ahead. A check on the cable as the vessel starts to turn would accentuate the turn, and produce astern-to orientation for the vessel. Stop main engines.
3. Let go the second anchor, and come astern on main engines, paying out the cable on the second anchor. As the vessel gathers sternway,

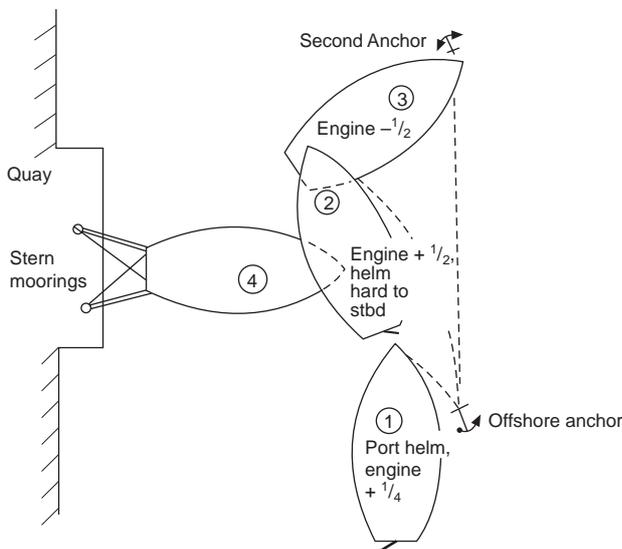


Figure 9.43 Mediterranean moor.

recover any slack cable on the offshore anchor. Stop engines and check the sternway on the vessel, as required, by braking on the cables.

4. Manoeuvre the vessel to within heaving line distance of the quay by use of engines and cable operations. Pass stern moorings to the quay. Tension on the moorings is achieved by putting weight on to the cables once the moorings have been secured on bitts.

Dredging Down

A vessel is said to be 'dredging down' when she is head to the wind and/or tide (stemming the tide), with an anchor just on the bottom. The amount of cable out is limited to the minimum to put the anchor on the bottom. Dredging down occurs when the vessel is not moving as fast as the current, which makes the rudder effective and allows the ship to manoeuvre. It is normal to expect a crabwise motion of the vessel over the ground, which is often employed for berthing operations. Used in conjunction with bold helm, the direction of the ship's head can be appreciably changed.

Snubbing Round

A vessel can turn head to tide without too much difficulty, provided that there is sufficient sea room to do so. Should the sea room not be available then a tighter turn will be required. This can be achieved by means of one of the ship's anchors, in the operation of snubbing round on the weight of the cable.

It is most frequently practised when the vessel has the tidal stream astern or in berthing operations. The vessel's speed should be reduced so that she can just maintain steerage way. Let go either the port or starboard anchors, at short stay, and allow the cable to lead aft, dragging the

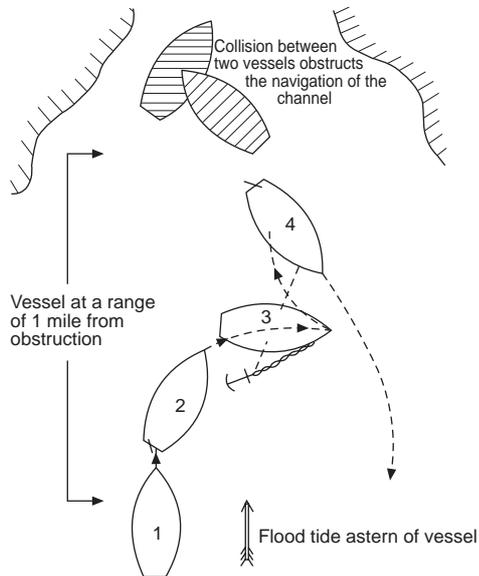


Figure 9.44 Emergency anchor to avoid obstruction.

anchor along the bottom. The cable will act as a spring, reducing headway, and canting the bow round towards the side from which the anchor was let go. The Master or pilot of the vessel should supplement this anchor/cable action by use of maximum helm and increase in engine power to bring the vessel through 180°. The anchor party should be briefed on the operation beforehand, and know, when to apply the brake to the cable, so giving the check on the vessel's forward motion that is necessary to complete the turn.

If the manoeuvre is attempted with too much headway on the vessel, excessive weight will be brought on to the cable as the vessel turns, which could result in the cable parting. In general practice, the anchor is let go to about a shackle, depending on the depth of water. The brake is then applied to start the turning motion on the vessel.

Anchoring in an Emergency

A vessel is approaching a channel in reduced visibility, speed 5 knots. The officer of the watch receives a VHF communication that the channel has become blocked by a collision at the main entrance (Figure 9.44). What would be a recommended course of action when the vessel was 1 mile from the obstructed channel, with a flood tide of approximately 4 knots running astern?

1. Assuming the vessel to have a right-hand fixed propeller, put the rudder hard a-starboard and stop main engines. The vessel would respond by turning to starboard. The anchor party should stand by forward to let go starboard anchor.
2. Let go starboard anchor. Full astern on main engines to reduce headreach. Letting go the anchor would check the headway of the vessel and act to snub the vessel round. Stop main engines.
3. Full ahead on main engines, with rudder hard a-starboard. Ease and check the cable as weight comes on the anchor. Once the vessel has stopped over the ground, go half ahead on main engines, allowing the vessel to come up towards the anchor and so relieve the strain on the cable. Heave away on the cable and bring the anchor home. Clear the area and investigate a safe anchorage or alternative port until channel obstruction is cleared.

INTERACTION

Most vessels will at one time or another experience some form of interaction with another vessel, perhaps through navigating in shallow water or passing too close to an obstruction. In this age of the big ship Masters and pilots should know exactly what interaction is and what the results of its occurrence may be.

Interaction is the reaction of the ship's hull to pressure exerted on its underwater volume. This pressure may take several forms (Figures 9.45 to 9.48).

Interaction in Narrow Channels

Vessels navigating in narrow channels (Figures 9.49 to 9.51) may also see telltale signs of interaction, e.g. when passing another vessel which is moored fore and aft. The interaction between the vessels will often cause the moored vessel to 'range on her moorings'. A prudent watchkeeper on that vessel would ensure that all moorings were tended regularly and kept taut. The experienced ship-handler would reduce speed when passing the moored vessel to eliminate the possibility of parting her mooring lines.

Another telltale sign, again in a narrow channel such as a canal, may be noticed when a vessel is navigating close to the bank. As the vessel proceeds, a volume of water equal to the ship's displacement is pushed ahead and to the sides of the vessel. The water reaches the bank and rides up it. Once the vessel has passed, the water falls back into the cavity in the ship's wake. The interaction in this case is between the hull of the ship and sides of the bank. An increase in squat may be experienced because of the loss of water under the vessel's keel. This may even bring about the vessel grounding. The effects may be reduced by a reduction in speed, provided steering is not impaired by such action.

Attention is drawn to MGN 18 regarding *Interaction between Ships*.

SHALLOW WATER EFFECTS AND SQUAT

When a vessel enters shallow water, she experiences a restricted flow of water under the keel, which causes an apparent increase in the velocity of water around the vessel relative to the ship's speed. Consequently, an increase in the frictional resistance from the ship's hull will result.

If the increase in the velocity of water is considered in relation to the pressure under the hull form, a reduction of pressure will be experienced, causing the ship to settle deeper in the water. The increase in the frictional resistance of the vessel, together with the reduction of pressure, may result in the ship 'smelling the bottom'. A cushion effect may be experienced, causing an initial attraction towards shallow water, followed by a more distinct 'sheer' away to deeper water.

Where shallow water is encountered in confined waters, e.g. channels and canals, a 'blockage factor' (Figure 9.50) must be taken into account. Ships may sink lower in the water when the blockage factor lies between 0.1 and 0.3; this, combined with a change of trim from the shallow water effect, is generally expressed as 'squat'. The result of a vessel squatting will be a loss of clearance under the keel, making steering and handling difficult.

Vessels navigating with a blockage factor between 0.1 and 0.3 push a volume of water ahead. This water, carried back along the sides of the channel to fill the void left astern of the ship, is often referred to as the 'return current'. The rate of the returning water has an effect on the ship's speed, and the maximum speed that the vessel can reach becomes a limited factor known as 'canal speed'.

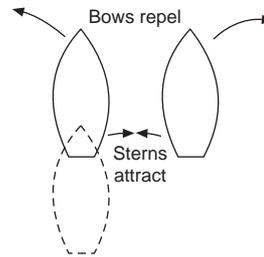


Figure 9.45 Overtaking, when two vessels are passing too close to each other on parallel courses. Interaction may occur when the vessels are abeam, resulting in deflection of the bows and attraction of stern quarters, with dangerous consequences.

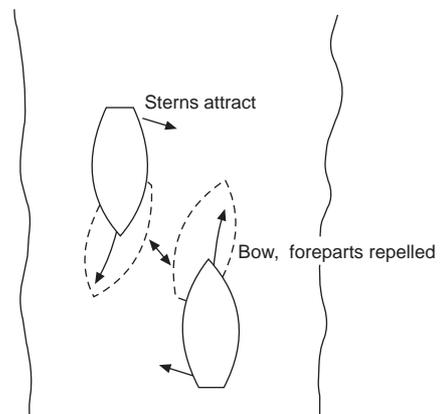


Figure 9.46 Interaction between two vessels on reciprocal courses.

The period of time in which interaction is allowed to affect both vessels is limited because the pressures and water cushions created only last during the period of passing. When vessels are on reciprocal courses, the length of time that the vessels are actually abeam of each other is short (as opposed to one vessel overtaking another).

No problems arise when both vessels have ample sea room. However, in narrow channels there is the danger of grounding or collision as bows are repelled and sterns pulled towards each other.

Figure 9.47 Situations involving interaction.

Above, interaction occurring between a vessel and a bank, sometimes referred to as a bank cushioning effect. A vessel with helm amidships may create an area of increased pressure between her hull and the bank. The result is that the vessel appears to be repelled from the bank while her stern is apparently sucked into the bank, with obvious dangers to rudder and propellers.

Below, interaction occurring between the vessel's hull and the sea bed when in shallow water (shallow water effect). When approaching a shallow water area, a vessel may initially be attracted to the shelving or the obstruction. However, as pressure builds up between the hull and the sea bottom, the vessel may experience a sudden and decisive shear to one side or the other. Rudder effect may also be reduced by turbulence caused by a reaction from the sea bottom.

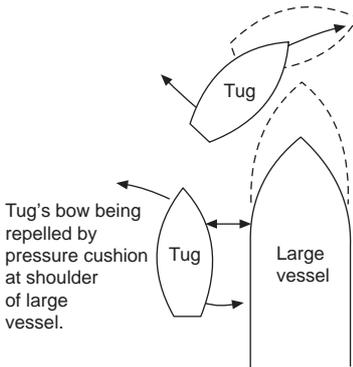
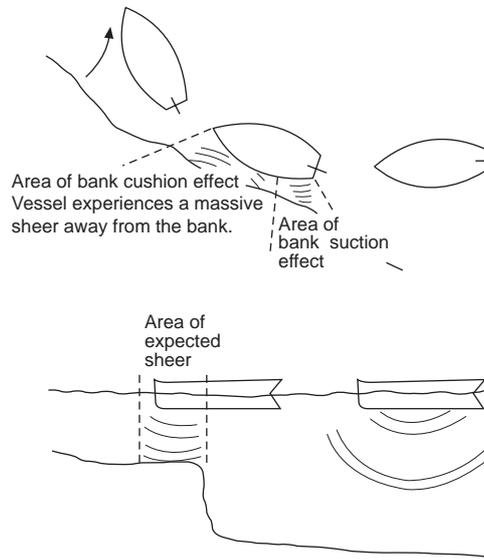


Figure 9.48 Interaction between large vessel and tug.

1. As the tug approaches the larger vessel to collect the towline, its bow is repelled by the shoulder of the larger vessel.
2. Counter helm is applied to correct the outward motion of the tug.
3. As the tug moves ahead under the bow of the larger vessel, it experiences an attraction to the larger vessel accentuated by the tug carrying the counter helm.
4. Unless prompt action is taken by the helmsman on the tug, the two vessels could collide, with the tug passing in front and under the larger vessel's bow.

Influencing Factors on Squat

1. The speed of the vessel.
2. The rpm in relation to the 'canal speed'.
3. The type of bow construction, which will affect the bow wave and distribution of pressure.
4. The position of the longitudinal centre of buoyancy (LCB), near or through which the downward force of squat will probably act.

Squat may occur by the head or by the stern. If the LCB is aft of the centre of flotation, a squat by the stern would be expected; and if the LCB is forward of the centre of flotation, the vessel would be expected to settle by the head.

The strongest influence on the amount of squat will be the speed of the vessel. As a general guide, squat is proportional to the square of the speed. A reduction in speed will lead to a corresponding reduction in squat.

WORKING WITH TUGS

The function of the tug is to assist the pilotage of a vessel. This function has brought many types of tug into being, the most common being the ocean-going tug and the smaller dock tug (Figure 9.52 and Plate 31). Extensive use of supply vessels in the dual-purpose role of supply and towing have caused design and construction firms to add towing facilities to many supply vessels. Use of tugs while entering a lock is shown in Figure 9.53.

The very nature of the employment of tugs underlines the fact that tremendous weight and stresses have come into play, with consequent risk to operators. Many accidents have occurred in the past on mooring operations, and a considerable number of these have been during the use of tugs and their tows.

Safe Handling of Towlines

1. Seamen should never stand in the close vicinity of a towline when stress is seen to be in the line.
2. Towlines should always be let go in a controlled manner (by use of rope tail from wire eye) to ensure that the tug's crew are not endangered.
3. Sharp angled leads should be avoided.
4. Chafe on towlines should be avoided, especially over long periods, by parcelling the towline and lubricating any leads employed. Means of adjusting the length of the towline to avoid continual wear and tear or in the event of bad weather should be provided.
5. It is not considered good seamanlike practice to secure the eye of a tug's wire over the vessel's bits. The control of the station is then passed to the tug, and the ship becomes dependent on the tug's Master to come astern. Effectively this eases the weight on the towline and allows the ship's personnel to slip the tow. However, in an emergency, if the eye had been secured over the bits, the ship's personnel would not have been able to release the towline.
6. When a ship's towrope is released from a stern tug, in the majority of operations main engines should be turning ahead. The screw race will tend to push the towline well astern and clear of the propeller. This also occurs with a towing wire when fitted with a nylon pennant. The majority of man-made fibre ropes float as they are stretched astern, providing the officer on station with more handling time to bring the towline aboard, without fouling the propeller.
7. After any towline has been secured by turns aboard the vessel, the weight should be taken to test the securing before the start of actual towing operations.
8. Efficient communications should be established between the bridge, the tug, and the officer on station, before starting the tow.

Girting or Girding

This is a term used to describe a tug being towed sideways by the vessel she is supposed to be towing. The danger arises when the towing hook is close to midships. The height of the towing hook is an important factor, as are the speed and rate of swing of the towed vessel.

This situation could be extremely dangerous if the tug's gunwales are dragged under by the force of the vessel under tow acting on the towline, especially if the weather deck of the tug has open hatchways. If in an emergency the tug's stern cannot be brought under the towline very quickly, the tow should be slipped (see Figure 9.54).

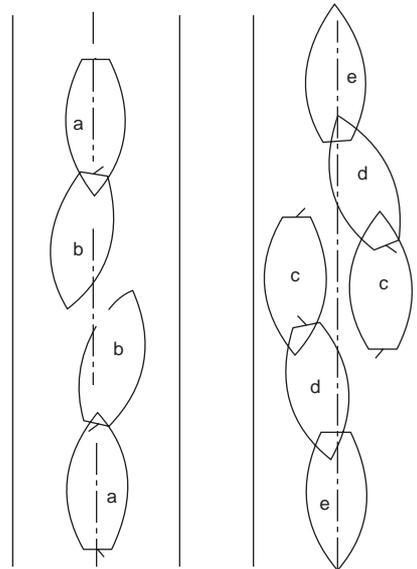


Figure 9.49 Recommended passing positions for two vessels in opposition in narrow channel.

The limits for vessels passing when navigating in narrow channels can often be extremely fine. Both vessels are recommended to reduce speed in ample time in order to minimise the interaction between ship and ship and ship and bank. Provided a sensible speed is adopted, it should prove unnecessary to alter the engine speed while passing, thus keeping disturbance and changing pressures to the minimum as the vessels draw abeam.

In normal circumstances each vessel would keep to her own starboard side of the channel (ab and cde), and good communications should be established before the approach to ascertain exactly when the manoeuvre will start. Efficient port/harbour control can very often ease situations like this simply by applying forward planning to shipping movements.

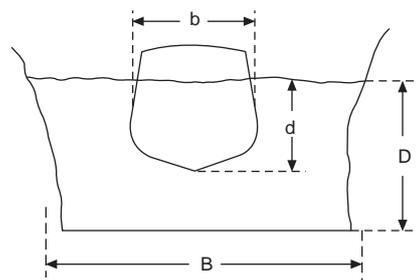


Figure 9.50 Blockage factor.

$$\text{Blockage factor} = \frac{b}{B} \times \frac{d}{D}$$

Example

Let $b = 45'$; $B = 100'$; $d = 26'$; $D = 78'$

$$\therefore \text{Blockage factor} = \frac{45}{100} \times \frac{26}{78} = \underline{\underline{0.15}}$$

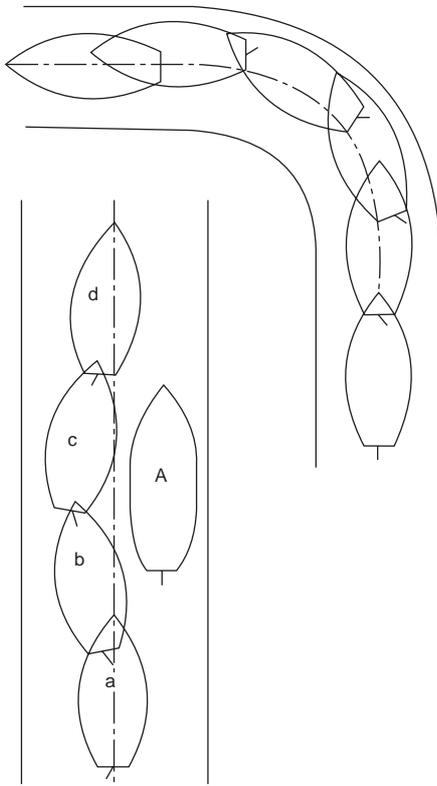


Figure 9.51 Recommended positions when rounding a bend (*above*) or overtaking another vessel (*below*) in narrow channels.

Long-distance Towing

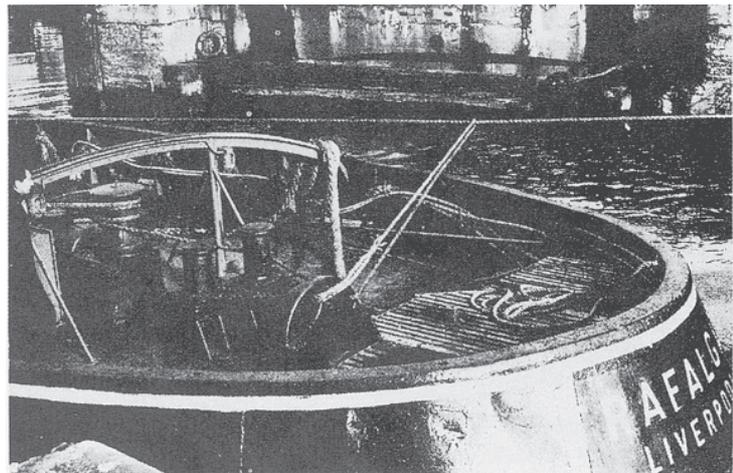
Should a vessel have to be towed, owing to engine failure or some other reason, then she will require secure towing arrangements aboard. Experience has shown that if an efficient method of securing is established at the beginning of the towing operation, considerable time and effort will be saved at a later date in the event of the towline parting.

One suggested method of forward securing is by means of a chain cable bridle, constructed from one of the towed vessel's anchor cables. (Figure 9.55). An anchor will need to be hung off, either in the hawse pipe or from the shoulder, leaving the second anchor housed in position and clear ready for use, should it be required.

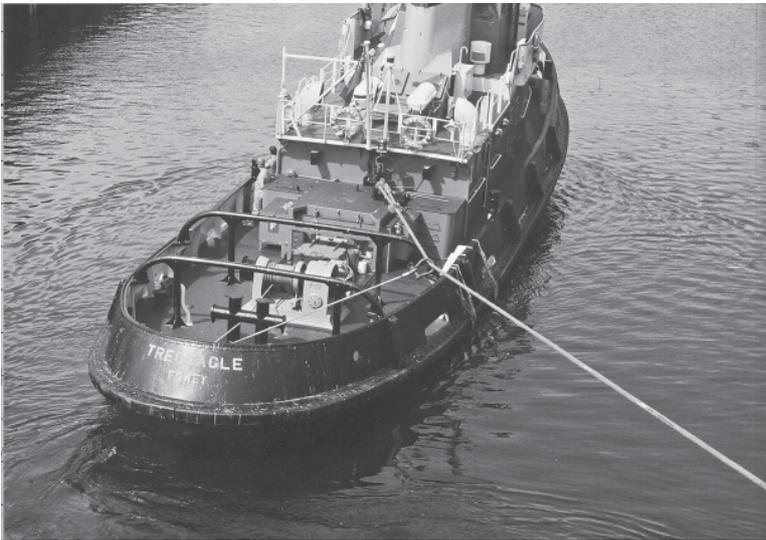
Preventer wires or relieving tackles, with the weight taken up, should be secured to the bight of the bridle before the towline is secured to it by a heavy duty shackle. Ample grease or other lubricant should be applied to the fairleads and bollards which are expected to take the full weight of the bridle once it is connected to the towing vessel.

The bearing surface of the chain bridle could be adjusted if relieving tackles are used instead of preventer wires, and that would prevent continuous chafe at any one point on the bridle. Lubrication and stress on the bridle should regularly be checked, but personnel should in general avoid the vicinity of the towline and bridle when weight is being taken up by the towing vessel.

The preparation of the chain cable bridle is a lengthy one and mariners should take account of the manpower required and the time to complete the operation before expecting to get under way. Securing the bridle is a lengthy process even in ideal weather conditions, but should the towline part, say in heavy weather, the mariner may find the task of re-securing the tow even more difficult.



31. Gob rope in use with a ship's towline on the afterdeck of a docking tug. Tension is achieved in the gob rope by means of a centre line capstan. The 'towing rail' is clearly seen running a thwartships.



32. Alternative type of gob rope (wire) and electric winch.

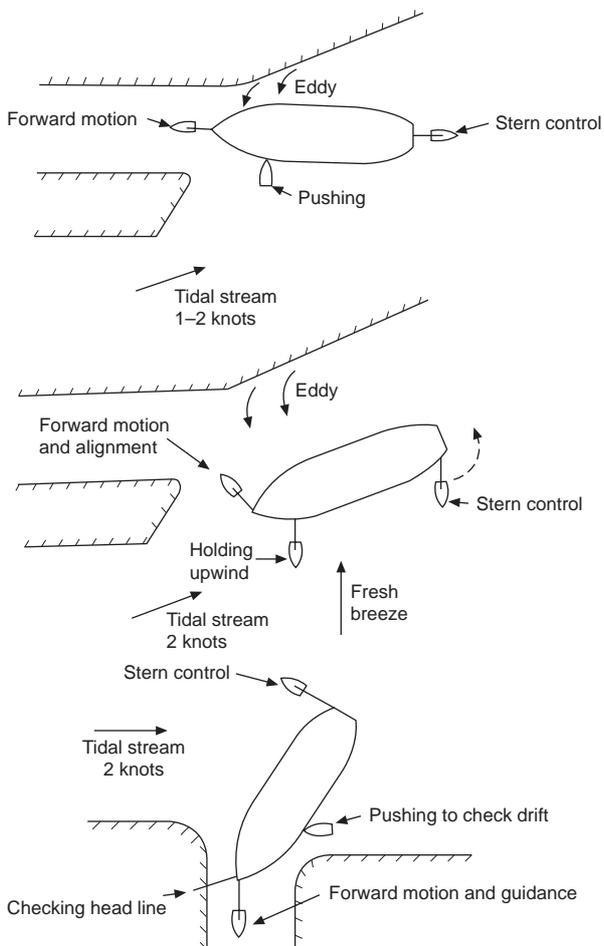
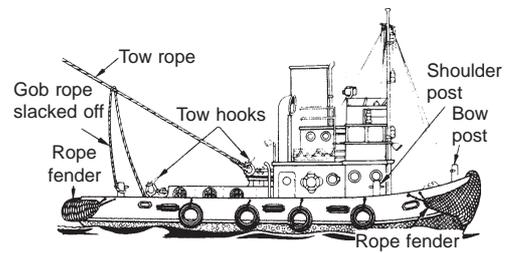
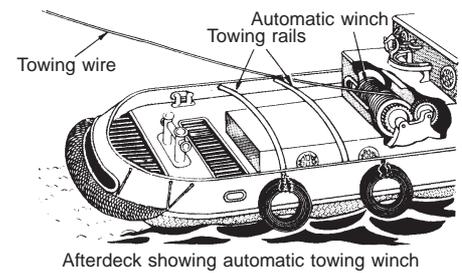


Figure 9.53 Entering a lock – use and deployment of tugs.



Afterdeck showing automatic towing winch

Figure 9.52 Dock tug.

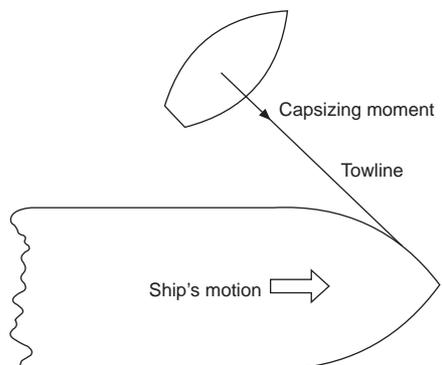


Figure 9.54 Girting or girding.

Alternative Towing Methods

See Figure 9.56.

1. The towing vessel's insurance wire can be combined with the anchor cable of the vessel under tow. The wire from the towing vessel can be secured around the mast, about the aft mast housing, the deck house or the poop itself. Sharp leads will need to be well parcelled and protected by wood to prevent chafe and the tow parting. The main disadvantage of using the anchor cable of the towed vessel is that the anchor is usually hung off at the shoulder, and the vessel under tow cannot use this anchor in an emergency. This fact may not seem important at the onset of the tow, but the anchor could play an important role in reducing the ship's momentum once the destination has been reached. The obvious advantage of employing the anchor cable is that the length of towline can be adjusted by direct use of the windlass. The anchor may remain in the hawse pipe, with the cable passing through the centre lead (bullring if fitted).
2. An alternative method of towing is possible when the tug is fitted with an automatic winch. The handling of the towline is made relatively easy once the cable or chain bridle of the vessel under tow has been secured. The lengthening and shortening of the towline is carried out by manual operation of the winch, while the tension in the towline is controlled automatically under normal towing conditions. This method should not be attempted by vessels using a conventional docking winch, as the additional strain brought to bear on the axis of the winch could render it inoperative.
3. A wire towing bridle can be used. In this method the towing bridle is secured to the vessel doing the towing operation, not the vessel being towed. This bridle is rigidly secured in position by preventer tackles and set around the after housing (poop area). Sharp corners should be well parcelled to prevent chafe and lubricants applied to bearing surfaces of the towline whenever necessary.

A combination of 'rope spring' and steel wire hawser is employed, with the wire hawser being secured around four sets of bits. The main advantage of this method is that both anchors are left ready for use, but adjusting the length of the towline can prove a lengthy and sometimes dangerous task.

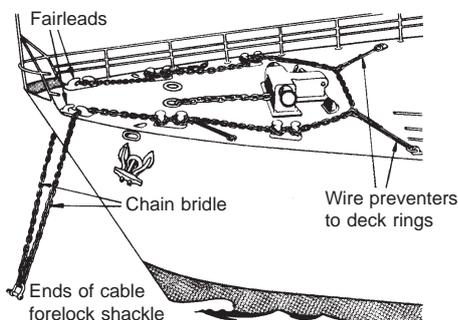
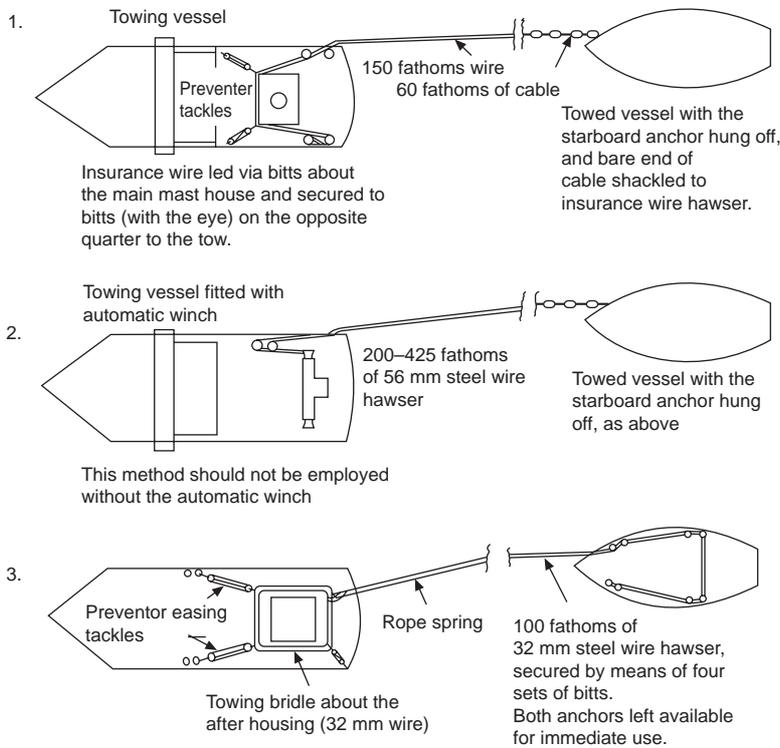


Figure 9.55 Method of securing chain bridle.



Examples 1 and 2 show use of composite towlines employing tugs towing spring and the towed vessels anchor cable.

Figure 9.56 Towing methods.

Use of Two Tugs

This method (Figure 9.57) has the obvious advantage of giving more power on the towlines and increasing the speed of the tow. However, the expense of employing two tugs instead of one is considerable, especially if one tug can manage the job, though taking a little longer. Certain heavy ULCC and VLCC vessels would, of course, need two or more tugs.

The use of two tugs, one off each bow, has the effect of reducing the yaw of the vessel under tow. Towlines secured on each side will vary in length and construction but should be such as to lead approximately 30° away from the fore and aft line of the parent vessel. This method is often used for towing floating drydocks and the like, as it achieves greater manoeuvrability.

Emergency Towing Arrangements for Large Tankers

In November 1983, the IMO adopted resolution A535(13) regarding emergency towing arrangements applicable to new tankers of 20,000 or over.

The purpose of the resolution, which was published in 1984, and amended, was primarily to reduce the risks of pollution. Recommendations regarding specialised fitments to applicable vessels are as follows:

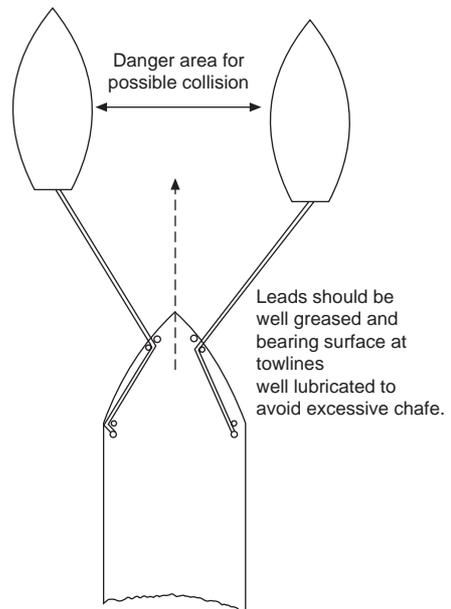
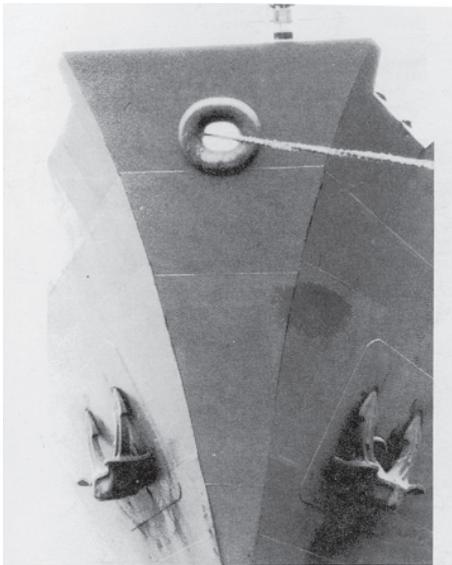


Figure 9.57 Towing by two tugs.



33. Bow section showing centre Panama Lead (Bullring) which can be employed for towing and could eliminate the need to hang an anchor off at the shoulder.

Major Towing Components

For the tug or towing vessel. The towline, a pennant, a chafing chain, a fairlead, and a towing gear connection or strongpoint.

For the vessel being towed: a system which facilitates ease of connection, which is capable of connecting and releasing aboard the towed vessel in the absence of main power.

A standardised point of connection between the towline and the chafe chain should be used.

The Applied Requirements

Emergency towing positions should be fitted at the bow and stern positions of respective vessels. Where a tanker of 100,000 tonnes or over, was built before the adoption of resolution A535(13) then these vessels should have the towing positions fitted at the first scheduled dry docking following adoption but not later than five years after adoption, each position being fitted with a strongpoint, fairlead and chafing chain.

All components of the towing system, including the supporting structure should have a working strength of at least 2000 kN.

The strength being sufficient for all angles of the towing up to 90° from the ship's fore and aft line.

Location and Geometry

The position of the strongpoint and fairlead should be such as to allow towing from either side of the bow or stern. The axis of the towing gear should be, as far as practical, parallel to and not more than 1.5 m either side of the centre line. The fairlead should be positioned in relationship with the strongpoint so that distance between them is not less than 2.7 m and not more than 5 m so sited that the chafing chain lies approximately parallel to the deck when under strain.

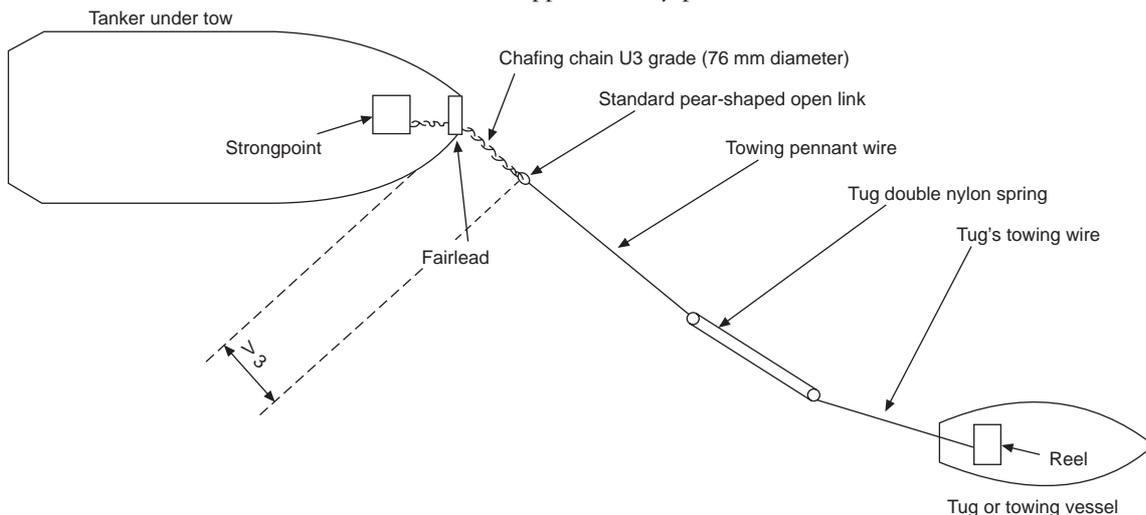


Figure 9.58 Example of emergency towing arrangements for large tankers. Additional reference Volume III, Command Companion of Seamanship Techniques DJ House (2000).

TANKER WORK AND OIL POLLUTION



A large percentage of merchant fleets, not just the British merchant navy, have considerable tonnage in the way of tanker type vessels, the majority of which are carriers of crude oil and the associated oil products. Oil cargoes are usually carried in very large crude carriers (VLCCs) up to 350,000 DWT. Other refined products from the oil industry, e.g. diesel oils, kerosene and gas oils, are normally carried in the smaller product carrier vessels. It is accepted practice that the majority of vessels carry the same type of cargo year after year. This avoids contamination of different categories of oil, and the need to carry a variety of gear for different cargoes, and more than one pumping arrangement.

The obvious hazards in the carriage of these cargoes are fire with or without explosion, the emission of toxic vapours, and oil pollution. Tanker personnel need to understand the following points about the dangers of their calling:

1. *Flashpoint* (of an oil). This is the lowest temperature at which the oil will give off vapour in quantities that when mixed with air in certain proportions are sufficient to create an explosive gas.
2. *Ignition point* (of an oil). This is the temperature to which an oil must be raised before its surface layers will ignite and continue to burn.
3. *Volatile liquid*. This liquid has the tendency to evaporate quickly, and has a flashpoint of less than 60°C.

TANKER VESSELS

General Petroleum Tankers

Crude oil carriers, mainly the larger type of tanker, these comprise:

1. Supertankers of 50,000 to 160,000 tonnes.
2. Very large crude carriers (VLCCs) of 160,000 to 300,000 tonnes.
3. Ultra large crude carriers (ULCCs) of 300,000 tonnes and over.

Refined Product Carriers

Mainly smaller tankers up to 50,000 tonnes, these are divided into carriers of *clean oils* such as motor spirit, naphtha, kerosene and gas oil; and carriers of *black oils* such as fuel oil, diesel oils and furnace oils, carriers of one category never move into the other.

Specialised Carriers

Vessels falling into this category generally require specialist construction and operating procedures. Examples include gas carriers, chemical carriers, liquid (molten) sulphur carriers, bulk wine carriers and bitumen carriers.

TANKER HAZARDS AND PRECAUTIONS

Fire and Explosion

1. *The most dangerous condition of an oil tank* is when the cargo has been discharged, and before any tank cleaning and gas freeing has been carried out. When a cargo tank is full, the possibility of fire is present but explosion risk is quite small since the air/hydrocarbon vapour atmosphere above the oil is small. When the tank is empty, however, the air/hydrocarbon vapour atmosphere is at its maximum. If the atmosphere is within the flammable limits for air/hydrocarbon mixtures, the tank is extremely susceptible to explosion.
2. *Oxygen analyser and explosimeter.* Oxygen analysers come in several forms. Some are electrically operated and can give continuous readings of oxygen content of the atmosphere being sampled. Others measure oxygen content of the sample by chemical reaction and will only last for a limited number of tests before renewal of the chemical is required. These oxygen analysers are used to check whether there is sufficient oxygen in an enclosed space to support life, as well as in other tanker operations where oxygen content is required.

An explosimeter is designed to measure the flammability of a gas sample. The instrument is calibrated to read from 0 to 100 per cent of the lower flammable limit of the gas sample. For most air/hydrocarbon atmospheres in normal tankers the lower flammable limit (LFL) is about 1 per cent hydrocarbon gas by volume whilst its upper flammable limit (UFL) is about 10 per cent hydrocarbon gas by volume.

3. *Fixed fire-fighting systems.* These systems are permanently installed systems with a specific coverage and function. These systems take many forms of which the following are some of the more commonly used.

Fixed foam systems utilise a centralised foam tank to supply a fixed system covering a specific area that may be susceptible to oil fires. Typical areas covered by fixed foam systems are engine-room and boiler-room bilge areas and pump-room bilge areas. A tanker's main cargo deck is often covered by fixed foam monitors supplied from a centralised foam tank. The most commonly used foam is of a

protein-based type which uses water as its drive and combining agent. Specialised foams such as Hi-Ex (high expansion) foam may be found but are not, as yet, the most common type.

Foam is the best agent for extinguishing oil fires, as it floats across the surface of burning oil and thus reaches wherever the oil itself reaches. Once the surface of the oil is covered, the fire is effectively smothered. The foam blanket must be maintained until the oil temperature has fallen sufficiently to reduce the risk of re-ignition.

Fixed CO₂ (carbon dioxide) systems utilise a centralised CO₂ room containing the required number of CO₂ gas cylinders to provide coverage for the area being protected. The CO₂ bottles are pressurised and thus provide their own drive when released. The CO₂ is used to displace air from a fire, thus smothering it. CO₂ is a non-conductive agent and can thus be used in the area of electrical switchboards and is also used for pump-room smothering, though electrostatic charging has to be guarded against.

Fixed BCF (bromochlorodifluoromethane) is a vaporising liquid which is an excellent smothering agent but is costly and, like CO₂, is only usable once and is not fitted to many vessels on the large scale employed with most fixed systems. It is sometimes found as a fixed system in emergency generator rooms of the diesel-operated type.

Fixed dry powder systems are frequently found in emergency diesel generator rooms. The dry powder smothers the surface of the fire; it is non-conductive and may be used on electrical equipment, though it may cause damage due to its abrasive properties.

Steam smothering systems may be used, particularly in older vessels, for smothering cargo and pump-room spaces. Steam smothering does not help to reduce temperature and may sometimes cause gas generation from oil which it may heat.

Water wall systems are often fitted at the front of tanker deck-houses to stop radiant heat affecting the accommodation owing to a cargo tank fire. Water is pumped through spray nozzles, high on the accommodation front, and falls as a water curtain.

Inert gas is not specifically a fire-fighting system but may be utilised in cargo tanks. It is often possible to fit a portable bend to allow inert gas into a pump-room space.

4. *Portable fire-fighting equipment.* Small portable fire-fighting equipment is designed to act as first aid in the event of a fire. If a fire is tackled at an early stage, it may be put out by small portable equipment. If a fire is larger than can be handled by small portable equipment, then larger equipment requiring greater manpower must be used or one of the fixed systems may be resorted to, if available. Small portable equipment is supplied in many types similar to the fixed systems except in their size.
5. *Common sources of ignition:*
 - Smoking* – particularly dangerous are striking matches or lighters.
 - Galleys* – oil or electric, i.e. burners, toasters etc.

Accommodation electrical equipment – not usually designed to be gas-tight so flammable gas must be kept out.

Metals – ferrous and non-ferrous metal tools should be used with care. Non-ferrous metal tools are only marginally less likely to cause incendive sparks and have other drawbacks such as the danger of ‘thermite’ spark or flash which may be incendive in the presence of flammable gas.

Spontaneous combustion can occur with most combustible organic materials, some being more susceptible than others. Auto-ignition was previously discussed, and is a serious hazard where oil may come into contact with hot surfaces (see pp. 173, 177 and 186).

Ship/shore electrolytic may occur in sufficient intensity to cause incendive sparks at a ship’s manifold and insulating pieces are frequently used to reduce this risk.

Static electricity can be generated by fluid flow.

Lightning during thunderstorms or electrical storms should cause a cessation of operations whilst it is in the vicinity of a tanker.

6. *Intrinsically safe.* A circuit, or a part of a circuit, is intrinsically safe when any spark or thermal effect produced normally, or accidentally, is incapable, under prescribed test conditions, of causing ignition of a prescribed gas or vapour.
7. *Tanker Safety Guides.* The Tanker Safety Guide issued by the International Chamber of Shipping should be available for reference on all tankers. Tanker owners also issue their own rules and regulations and these should be read and adhered to.
8. *Emergency plans and procedures.* Emergency plans and procedures to cover all foreseeable situations should be drawn up and then practised at regular intervals. On first joining a ship, the prudent mariner will familiarise himself with the plans and procedures for the ship and his position in those plans. Careful attention should be paid during practise sessions so that the need to think in an emergency is kept to a minimum, everyone should automatically do the correct thing even under the stress of a possible panic.
9. *Ship/shore checklist* (see p. 253).

DANGERS OF PETROLEUM SPIRIT

Should petroleum ignite, it is the vapour given off by the liquid that burns, not the liquid itself. However, temperatures are such that the liquid vaporises quickly. As with all fires, the vapour will only burn if the air/oxygen supply has access to the fire. The volume mixture of vapour to air defines the upper and lower explosive limits, which normally lie between 1 and 10 per cent.

Once a liquid is burning, volumes of gas will be given off. The consequences of the build-up of this gas, especially in an enclosed space, could be disastrous and lead to explosion. Risk of explosion is more likely with the expansion of the gas within the space.

Petroleum vapour can have a variety of effects on the human body, depending on the quantity. Some types of vapour are toxic, and if inhaled

TABLE 10.1 Ship/shore (tanker) officer's example checklist

VESSEL BERTH No.	DATE TIME			
1. Are SMOKING regulations being observed?				
2. Are GALLEY requirements being observed?				
3. Are NAKED LIGHT requirements being observed?				
4. Are electric cables to portable equipment disconnected from power?				
5. Are the ship's main transmitting aerials switched off?				
6. Are hand torches of an approved type?				
7. Are portable R/T sets of approved design?				
8. Are all external doors and ports in the amidships accommodation closed?				
9. Are all doors and ports in the after accommodation that are required to be closed in fact closed?				
10. Are ventilators suitably trimmed with regard to prevailing wind conditions?				
11. Are unsafe air conditioning intakes closed?				
12. Are window-type air conditioning units disconnected?				
13. Is ship securely moored and agreement reached on use of tension winches?				
14. Are cargo/tanker hoses in good condition?				
15. Are cargo/bunker hoses properly rigged?				
16. Are unused cargo/bunker connections blanked?				
17. Is stern discharge line (if fitted) blanked?				
18. Are sea and overboard discharge valves (when not in use) closed and lashed?				
19. Are scuppers effectively plugged?				
20. Is the agreed ship/shore communication system working?				
21. Are all cargo/bunker tank lids closed?				
22. Are cargo tanks being loaded or discharged open to atmosphere via the agreed venting system?				
23. Are fire hoses and equipment ready for use?				
24. Are emergency towing wires correctly positioned?				
25. Is the ship ready to move under its own power?				
REMARKS:				

We have checked with each other the items on the above checklist and have satisfied ourselves that the entries we have made are correct to the best of our knowledge.

CHECKED BY: _____ (for ship) _____ (for Terminal)

in a large enough quantity could prove fatal. If a lesser quantity is inhaled the person exposed may develop the symptoms of a drunken state. A person's sense of smell may also be affected by petroleum vapour, so reducing the body's warning systems for detecting the presence of gas.

GENERAL DEFINITIONS

Clean Ballast

Clean ballast is water carried in a cargo tank that has previously been thoroughly washed, as have the pipelines serving it.

Dirty Ballast

Dirty ballast is water carried in an unwashed tank or ballast that has been contaminated with oil from another source, e.g. loading through dirty pipelines will contaminate ballast.

Gas Lines

When loading, the air or gas originally inside the tank must be allowed to escape or pressurisation will occur. The gas lines connect at the top of the tank and allow this air or gas to escape.

Inert Gas

This gas, which is low in oxygen content, is obtained from the funnel uptake or an inert-gas generator. It is pumped into tanks while cargo is being discharged to reduce the risk of fire or explosion.

Manifold

That point on either side of the vessel where the ship's pipelines are connected to shore pipelines is the manifold. It is usually about the midships point. The valves on the ship's pipelines near the intersection with the manifold are known as the manifold valves.

Permanent Ballast

Ballast water carried in tanks specifically designed for its carriage, known as permanent ballast. There must be no possibility of the tanks being connected to the oil cargo system. (This ballast is not to be confused with the permanent ballast in dry cargo vessels, e.g. concrete blocks.)

Pipelines

These are the pipes used to move cargo around, both when loading and discharging and for any other transfer operation undertaken.

Sounding

The distance from the bottom of the tank to the surface of the liquid in that tank is the sounding. Ullage plus sounding equals the depth of the tank.

Ullage

This is the distance from the measuring point at the top of the tank to the surface of the liquid in that tank.

CARGO-HANDLING EQUIPMENT

Automatic Tank Ullaging Gauge

An automatic gauge sited at the cargo tank and giving continuous reading of ullage, this may be modified to give a remote reading in a control room. It may be operated by spring-tensioned tape and float, by pressure tube, by ultrasonic transducer, or any other approved device.

Flameproof Gauze

Portable brass gauzes are used to cover open sighting ports to stop any flame or spark from flashing back into the tank. Permanent types are fitted in gas lines to prevent flashbacks.

Linen Tape and Brass Weight or Wood Block

Hand-operated, this tape may be used for ullaging or sounding when fitted with a brass weight, but only for ullaging when fitted with a wood block. This type is prone to slight errors, owing to stretch, particularly when the tape is old.

Sighting Port Spanner

The sighting port on the top of a tank hatch may have various types of closing arrangement which usually require a special type of spanner (see Figure 10.1).

Sounding Rod

This rod is usually about 1 m in length and made of brass. It may comprise several short lengths linked together for use in sounding tubes that have bends in them, or it may be solid for other tanks and straight tubes. The rod is attached to a suitable length of line, and may only be used for soundings. Solid rods are frequently used for final 'dips' of oil cargo tanks to find the amount of residues remaining.

Specific Gravity (SG) Glass and Hydrometer

This is a tall sample glass into which is poured a sample of oil from the tank. The hydrometer is then used to measure the specific gravity of the oil, which is used, in conjunction with the oil's temperature and volume, in obtaining the weight of the cargo.

Steel Tape and Brass Weight

Hand-operated, this combination may be used for ullaging or sounding as required. It must not be used where electrostatic charges are present in tank atmospheres, as lightning-like arcing can be a source of ignition.

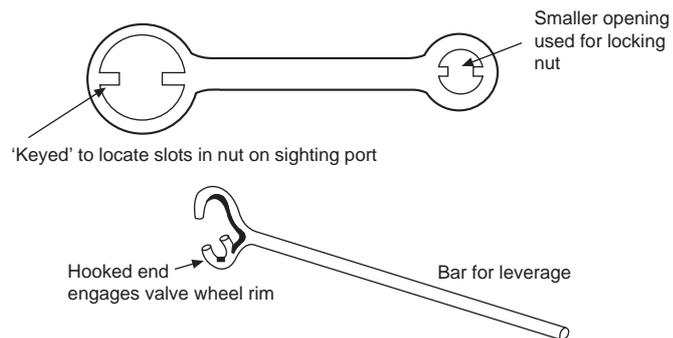
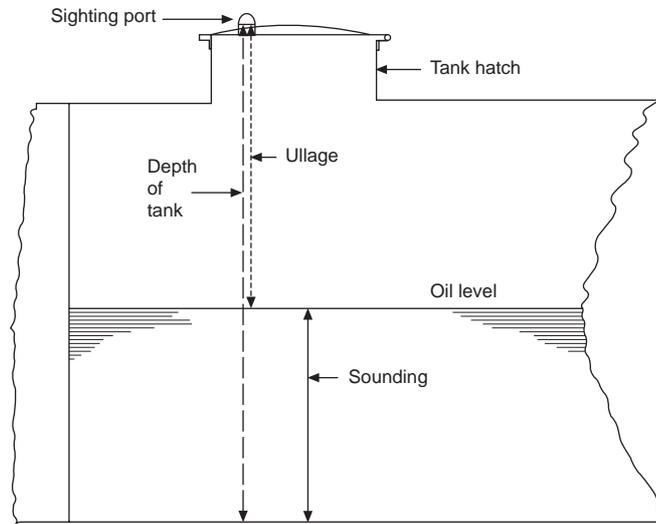


Figure 10.1 Tank measurements (above) and port spanner and wheel key (below).

Temperature Can and Thermometer

The temperature can is made of brass with a narrow neck and weighted base so that it will sink on entering the oil and thus fill with oil. The can is left in the oil for sufficient time to reach the same temperature as the oil, it is then hove up and a thermometer is used to find the temperature. In some cases the thermometer is left in the can when it is in the oil. The can may be adapted for use in obtaining samples of the oil, though a similar but larger sampling can is generally used for this purpose. The temperature of the oil cargo is used in calculating the weight of the cargo.

Ullage Stick

This simple graduated stick about 2 m in length has a cross-piece at the zero graduation mark, and this cross-piece on the ullage opening (usually the sighting port). The stick is used when open loading to finish off a tank, as it only measures the last 2 m of ullage.

Wheel Key

A metal bar with a hook type of end, the wheel key engages with the rim of a valve wheel so that increased leverage is obtained for opening or closing the valve (see Figure 10.1).

Tank measurements are shown in Figure 10.1.

WHESOE TANK GAUGE

The function of the gauge (Figures 10.2 and 10.3) is to register the ullage of the tank at any given time, in particular when the liquid level in the tank is changing during loading or discharging. The gauge is designed to record not only at the tank top but also in a central control room, a transmitter being fitted to the gauge head for this purpose. A particularly useful addition to oil tankers with numerous tanks, it allows the reading of all tanks to be carried out at one central control room.

The unit is totally enclosed and of rugged construction in a non-ferrous metal. Inside the housing is a calibrated ullage tape, perforated to pass over a sprocket wheel and guided on to a spring-loaded tape-drum. The tape extends into the tank and is secured to a float of critical weight. As the liquid level rises or falls, the tape is drawn into or extracted from the drum at the gauge head.

The tape-drum is internally spring-loaded and provides a constant tension in the tape, at the float connection, regardless of the amount of tape paid out. A 'counter window' for displaying the tape and fitted at the gauge head allows ullage readouts at any time. (The counter chamber is oil-filled.)

Located inside each tank are a pair of guide wires, each secured to an 'anchor bar' welded to the tank bottom. The upper end of the wires is

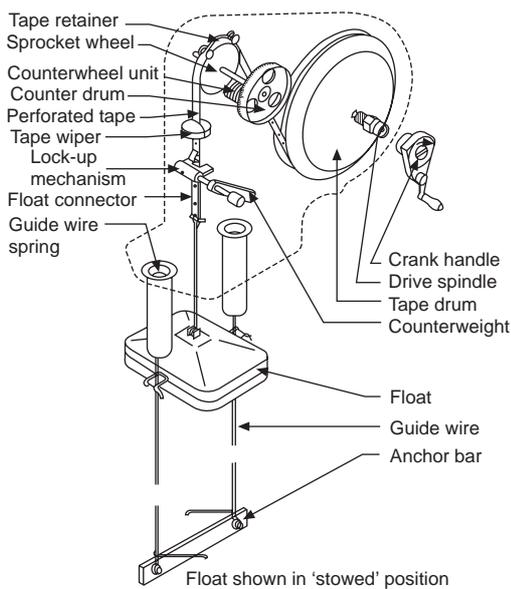


Figure 10.2 Whessoe tank gauge.

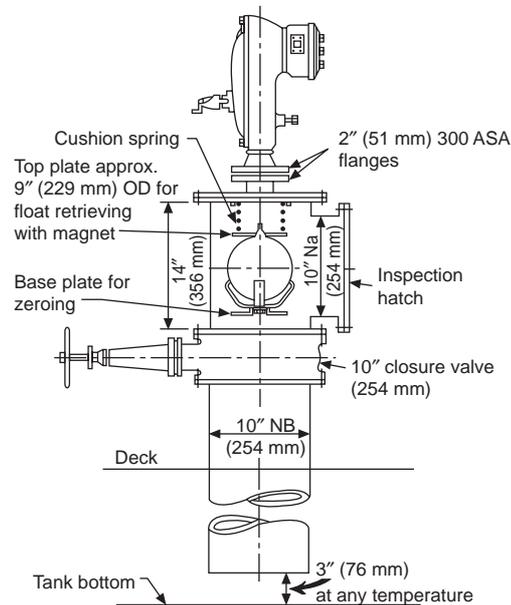


Figure 10.3 Whessoe tank gauge (Model No. 3303) for use with liquefied gas cargoes.

secured to cushion springs beneath the gauge. When the level indicator is not in use, the float is stowed in a locked position under the gauge head. An automatic lock-up arrangement of the float is achieved once the float is raised to its full extremity. Should this fail, the float can be secured manually.

GENERAL OPERATIONS AND PROCEDURES

Procedure when Loading

Clean ballast is discharged overseas, dirty ballast is pumped ashore. Tanks should be stripped as dry as possible; they are usually inspected by shore representatives before loading begins. Some tanks may remain empty, and these will usually be about amidships. During discharge of clean ballast, flexible shore hoses are connected to ship's manifold. After tank inspection, ship's lines are set, and loading is started slowly into one tank. When cargo is seen to be coming on board, more tanks are opened and the loading rate increased. A few minutes before completion, 'stand by' is given to the jetty man, and the rate is slowed down. The shore personnel are told to stop operations prior to required cargo levels being reached.

Procedure when Discharging

Ullages etc. are taken and the quantity of cargo on board is calculated. Ship's lines are set for cargo discharge. Simultaneously with these operations, flexible shore hoses are connected to the ship's manifold. When shore indicates that it is ready to receive, the appropriate tank suction valve and the manifold gate valve are opened. Pumping is then started slowly, a

careful watch being kept on the back pressure gauge (indication of valve shut ashore). When it has been established that cargo is being discharged, further pumps may be started and more tanks opened (subject to limitations made by shore).

Ballasting

When a tanker has no cargo to carry on a voyage, or there is insufficient cargo to provide enough sinkage for safety and to ensure the propeller is underwater, then the tanker can take ballast on board from the water in which it is floating.

Tank Cleaning

Where, for any reason, a cargo tank requires cleaning, then modern practice is to use fixed or portable tank-cleaning machines which automatically direct high-pressure jets about the tank in order to wash off oil and oil residues. The washings fall to the bottom of the tank and are then pumped to a special tank called a slop tank where they are retained until it is possible to discharge them to shore facilities (see Figures 10.4 to 10.6).

Safe Entry of Enclosed Spaces

Before one can enter a tank, it must be washed to remove oil so that no further gas can be generated. The tank must then be ventilated, which is usually accomplished by the use of water-driven portable fans or by a large fan in the engine room whose air can be directed to the tank required by the ship's gas lines. Even where a tank has had no oil in it and is clean, the atmosphere must be changed for fresh air, as even rust in a tank will extract vital oxygen from the air in it. Where inert gas has been used, this must be blown out, as it contains far too little oxygen to support life. See Guidelines on p. 268.

Action on Operating Failure

Where *any* operational failure occurs and no one of appropriate authority is present, then the safest course of action is to *stop* operations immediately. Any inconvenience caused by this action is negligible when compared to the possible consequences of continuing in a dangerous state, e.g. fire, explosion, overflow and/or pollution.

Duties of Officer of the Deck During Loading or Discharging

1. Tend moorings.
2. Tend the gangway and supervise the watchman's duties.
3. Calculate the rate of loading.
4. Check fire wires are correctly rigged and ready for use.
5. Check regularly for oil pollution.
6. Ensure that no hot work, naked lights or unsafe lights are left exposed.
7. See ship to shore checklist is observed.

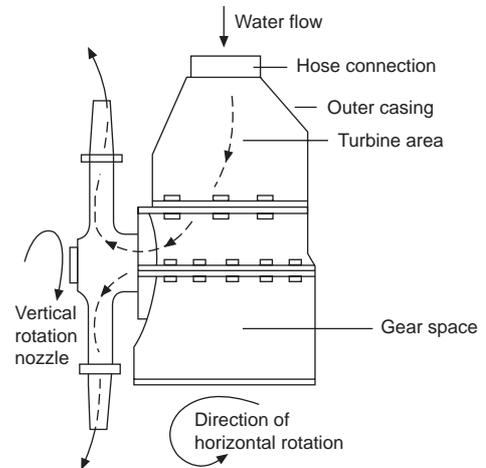


Figure 10.4 Simplified Butterworth 'K' machine. For the cleaning of small and medium tanks. General particulars are as follows:

small and compact, weighing less than 50 lb (23 kg); cleaning range of 10 m; fluid capacity of 31.5 m³ per hour; wash cycle times range from 50–23 minutes for inlet pressure of 3.5–12.3 kg/cm².

Figure 10.5 Butterworth 'Lavomatic SA' machine.

A deck-mounted system for crude oil washing (COW) on large, medium and small tanks, the Butterworth machine has been in use since 1973. It is a fast, economical system of tank washing which meets the standards of MARPOL, IMO, and the UK Department of Trade.

Tank cleaning may begin as soon as the cargo level falls below the wash head. A selection of washing arcs are available from -30° to 150° at 20° increments.

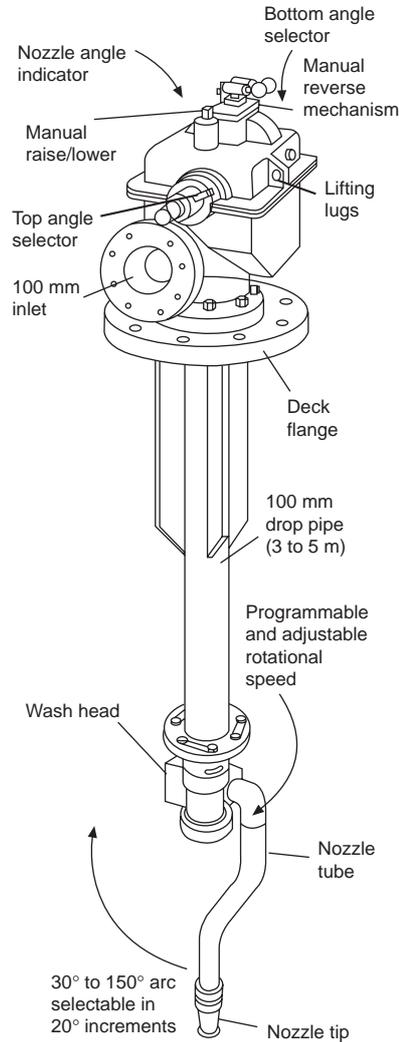
The machine requires 133 wash-head revolutions for a maximum cycle from -30° to 150° and back to -30° . Programme speed can be varied automatically and the system incorporates a manual override for nozzle direction and position.

Washing times can be considerably reduced by prudent adjustment of the revolving wash head. Typical settings would be, say, 1 rpm in the harder to clean lower regions of the tank, and $2\frac{1}{2}$ rpm in the upper easier to clean regions. The discharge rate of the machine would depend on the nozzle size, but the following examples are issued by the manufacturer:

Inlet pressure 10 kg/cm^2 (150 psi).

38 mm nozzle discharges about 150 cu.m per hour.

29 mm nozzle discharges about 100 cu.m per hour.



8. See all tank lids are closed and safe venting is being carried out.
9. Ensure oil loading into correct tanks.
10. Maintain state of heel and trim as required.
11. See that all oil hoses are supported and correctly secured.
12. Take care that electrically operated apparatus is used only if intrinsically safe.
13. Permit use of safe torches only.
14. See that means of access to accommodation is closed.
15. Ensure all scuppers plugged and drained.
16. Have fire-fighting equipment ready for immediate use.
17. Allow no unauthorised personnel aboard the vessel.
18. See that loading plan is observed and followed.
19. Have sufficient personnel available for topping-off purposes.
20. Ensure red light or 'B' flag is displayed.

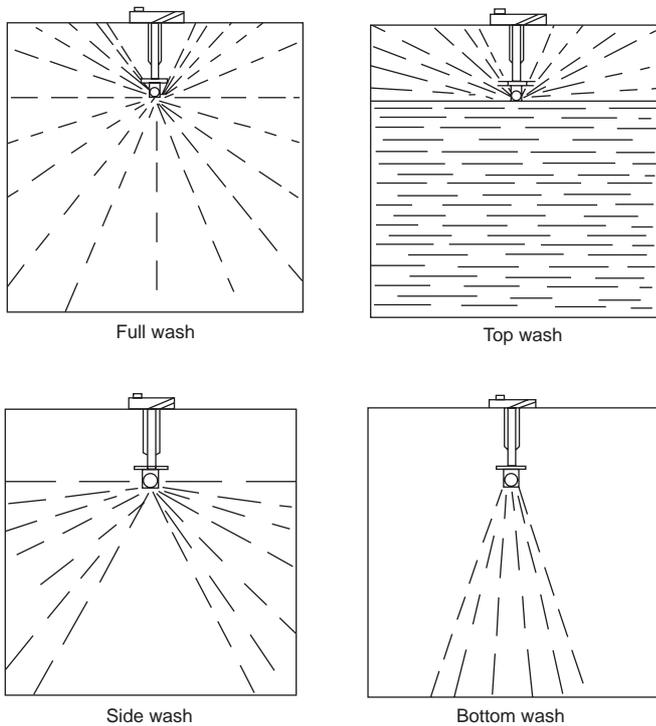


Figure 10.6 Washing cycle selection.

21. Have unused lines blanked off.
22. Make sure all company and port regulations are observed.
23. Establish efficient communications with shoreside personnel.
24. Keep deck log book up-to-date with current entries.
25. Maintain general deck watch, especially for changes in weather.
26. Check that inert gas system is isolated.
27. Avoid unnecessary pump-room entry. Have stand-by man available when entering.
28. See that drip trays are positioned.
29. Enforce no smoking regulations.
30. Forbid overboard discharges.

TANKER LAYOUT AND VENTILATION

Figure 10.7 gives a bird's eye view of tank layout, and Figures 10.8 to 10.10 cover ventilation.

HEALTH AND SAFETY

Accidents Due to Tanker Operations and Ship Design

Openings in the decks need to be covered and secured, which requires studs and nuts which project above deck level as much as 50 mm. These projections are usually obvious but during night-time operations, especially at sea, they can provide a serious danger, not only of stubbed toes, but of

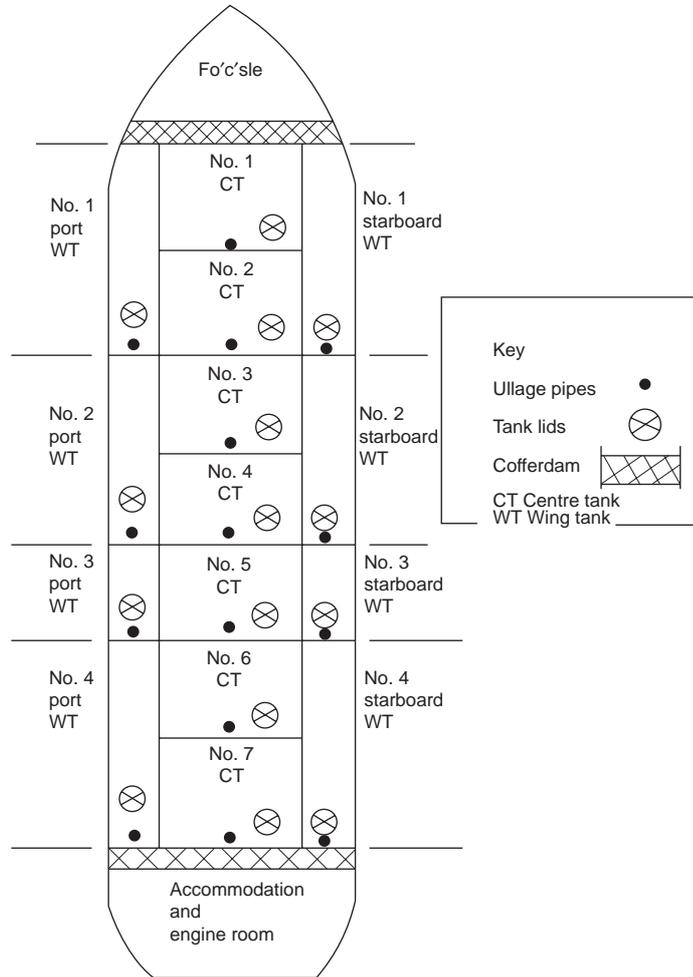


Figure 10.7 Ullage pipe and tank lid plan.

broken toes or even broken ankles and legs. During working hours, safety shoes should be worn, never loose fitting shoes or soft or open types of footwear.

Pipelines are ever-present on the decks of tankers; many are small and low and may be stepped over but many are large and their tops may be over 1 m above deck level. The larger pipelines will have walkways constructed across them at regular intervals and these should be used. To jump on top of pipelines to cross from one side of the deck to the other is extremely dangerous, as they are usually painted with gloss paint and falls between or from pipelines can cause all types of fractures and even death.

Overhead pipes and associated steelwork pose a very real threat and great care should be taken when passing under these. Safety helmets should be worn in the working environment.

Rarely does oil cargo find its way on to the tanker's decks but much of the equipment used on the tanker may require lubricating oil and the

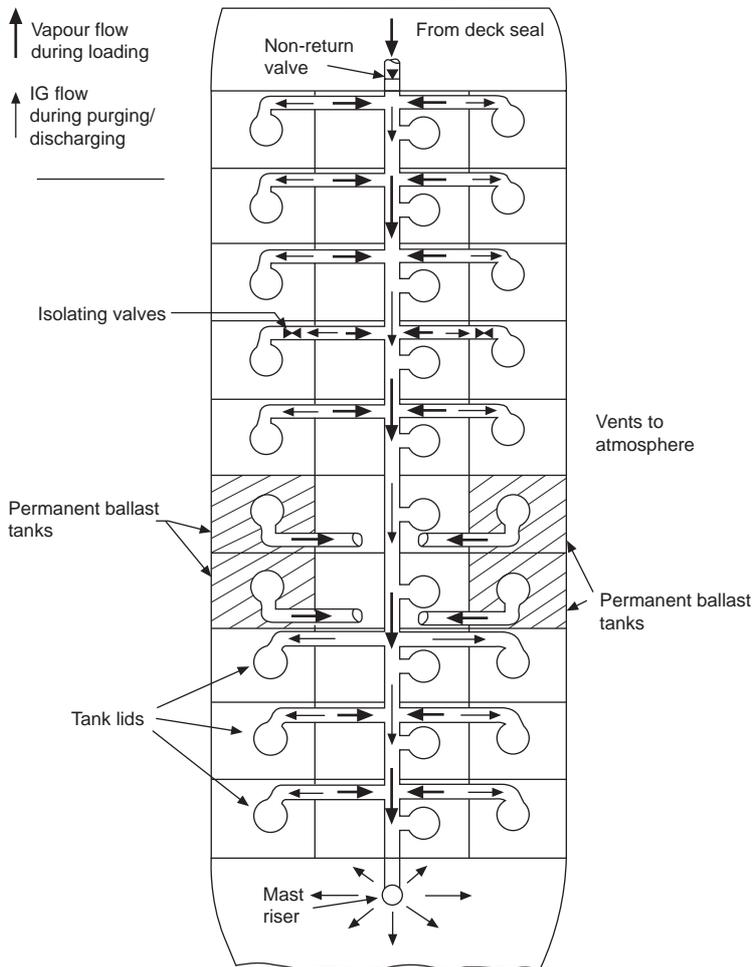


Figure 10.8 Gas venting system.

vessel may also use hydraulic oil for operating certain machinery. Oil leaks and seepages can form an almost invisible sheen on decks, which can be like ice. If water is present also, i.e. rain or sea water, then the situation becomes even more dangerous.

During operations on deck there is often the temptation to run from one area to another, especially if urged on by other persons. Running *must* be avoided as all the various dangers are accentuated for a running person. If you are being relied upon to complete an operation and you run to do it, and fall, there is a very good chance you will be at least unconscious; everyone is then in danger since the operation is out of immediate control. If you were walking and fell, it is far less likely that you would be totally disabled and, apart from a few second's delay, the operation could be completed.

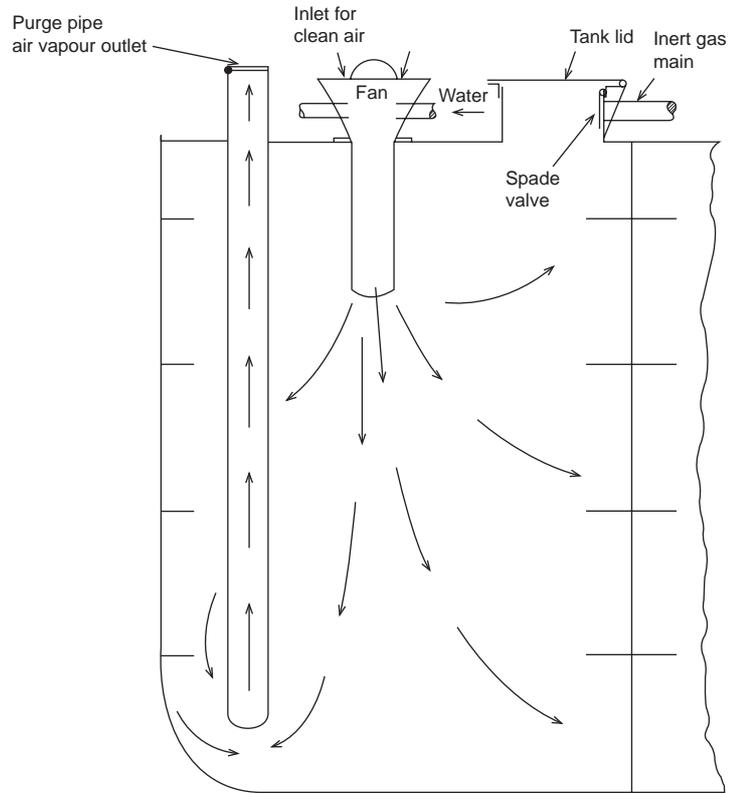


Figure 10.9 Cargo tank ventilation.

Inert Gas

Because inert gas is low in oxygen content, generally 5 per cent or less, it not only reduces fire hazards but also forms an asphyxiation risk. The human body is used to air containing 21 per cent oxygen and the average exhaled air is still in the region of 17 per cent oxygen; below 17 per cent content the air is no longer adequate for active life, and as the percentage falls the danger of death by asphyxiation rises. Where the presence of inert gas is suspected, the atmosphere should be tested for oxygen content before entry; if in doubt as to whether inert gas could or has been present, test anyway (see Figure 10.11). The compartment in question should also be continuously ventilated with fresh air.

Skin Contact with Hydrocarbons

Hydrocarbons are dangerous in many ways and in varying degrees, depending on their type. Certain hydrocarbons are thought to cause skin cancer if prolonged skin contact is maintained. Protective clothing such as gloves and boiler suit should be worn and kept clean. A dirty boiler suit is increasing skin contact time for any hydrocarbon with which it may be impregnated.

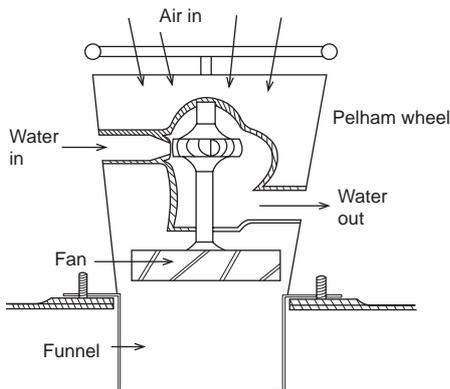


Figure 10.10 Gas-freeing (Axia) fan.

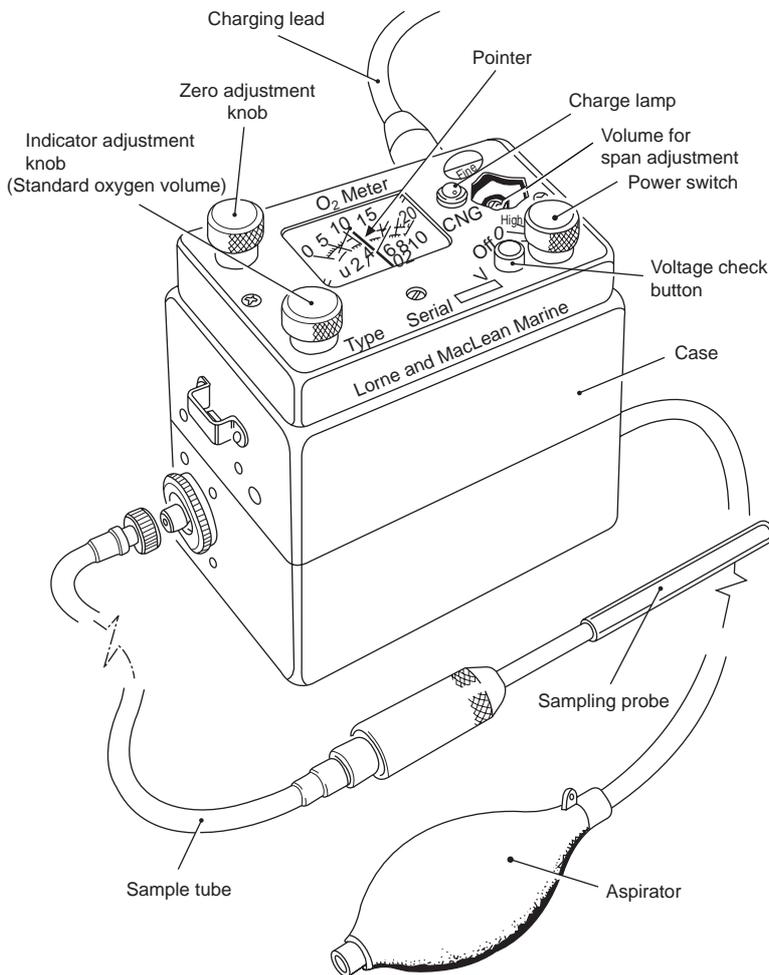


Figure 10.11 Oxygen test meter.

Inhalation and/or Swallowing of Hydrocarbons

Hydrocarbons and hydrocarbon vapours are, in varying degrees, toxic (poisonous). Hydrocarbon vapours are heavier than air and will displace air in a compartment from the bottom upwards, so that anyone entering a compartment will be at risk from asphyxiation through reduced oxygen levels and also poisoning from hydrocarbon toxicity. Whilst a re-entry into fresh air will remove the threat of asphyxiation, the toxic effect may remain. Certain hydrocarbons, e.g. of the aromatic family, can have a permanent cumulative effect and are particularly dangerous.

Where hydrocarbon gases are present, care must be taken to reduce the inhalation of these gases. The dangers due to swallowing hydrocarbons are also severe. Not only is long term toxicity of the body's cells a danger but immediate permanent damage to the throat, stomach and internal organs can also result.

Where a person is working in an atmosphere thought to be gas-free



Figure 10.12 Gas protection suit.

The gas protection suit shown here is designed for work in highly toxic atmospheres, e.g in cargo tanks etc. During such operations, the suit gives protection to the complete body. The suit is manufactured from extensible, abrasion-proof material, which is a highly durable polyester fabric, neoprene coated on one side. It is a one-piece suit, enabling the wearer to don quickly without assistance. Entry is effected through a diagonal aperture which is sealed with a gas-tight waterproof zip fastener. The sleeves are equipped with gas-tight cuffs or may be provided with gloves. The full vision facemask, with the universal, pneumatic seal and speech diaphragm, is bonded to the suit, allowing easy fitting for self-contained and airline breathing sets.

but starts to show symptoms similar to a drunken state, i.e. giggling, singing, lack of co-ordination, general fooling around etc. he is showing the first signs of hydrocarbon poisoning. A rescue procedure should be adopted immediately, so that the person can be removed safely from the poisonous atmosphere.

Protective Equipment

Compressed air breathing apparatus (CABA) comprises a face mask supplied with air from an air bottle carried by the user. In some cases the air may be supplied via a filter from a compressed air deck line (ALBA) but the user should also have a fully charged air bottle with him which will automatically continue to supply him with air should the deck air line supply fail. This provision is necessary to allow the person time to evacuate the space he is working in.

Automatic oxygen resuscitating equipment (Rescuepac) comprises oxygen bottles with automatic metering valves that will automatically supply a collapsed person with oxygen at the correct rate. This equipment is a powerful item of rescue equipment and should always be readily available in case of mishap when work is carried out in enclosed spaces.

Escape Sets and other Rescue Equipment

Escape sets are small CABA sets kept in positions where hydrocarbons may be released owing to operational failure, and they allow a person in that position sufficient air to effect an escape from the compartment. A typical position for an escape set would be at the bottom of a tanker's pump room.

Smoke helmets are mainly used for rescue and fire-fighting but may also be used for working purposes. The user wears a mask connected via a pipe to a bellows that must be situated in fresh air. The bellows may be mechanically operated but is more usually foot-operated. The pipe should be no longer than a length through which the user can draw air even if the bellows fails.

Lifelines and safety harnesses, the former steel cored and the latter made of terylene webbing, should be used where necessary.

Collapsed Person in Enclosed Space

Where any person or persons are working in an enclosed space, they must have a person outside the space whose sole responsibility is to watch them working to ensure their safety. If a person is seen to collapse in an enclosed space, the alarm must be raised immediately so that a rescue team with protective equipment (Figure 10.12), resuscitating equipment, lifelines and agreed communication systems can enter the space and carry the person to the nearest fresh air source (Figure 10.13). It is essential that the observer does not enter the compartment; he must raise the alarm and entry into the space must be made only by the rescue team with the correct equipment.

A gas detector is shown in Figure 10.14.

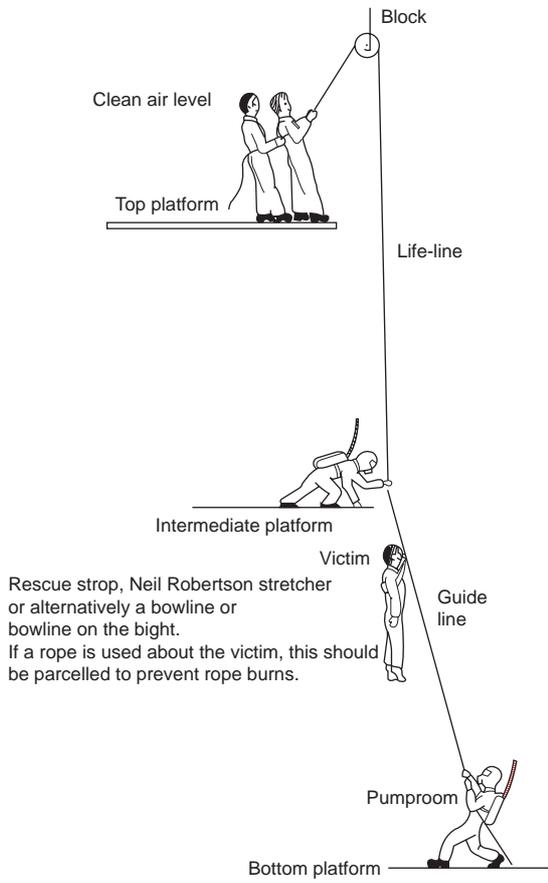


Figure 10.13 Pump-room rescue operation.

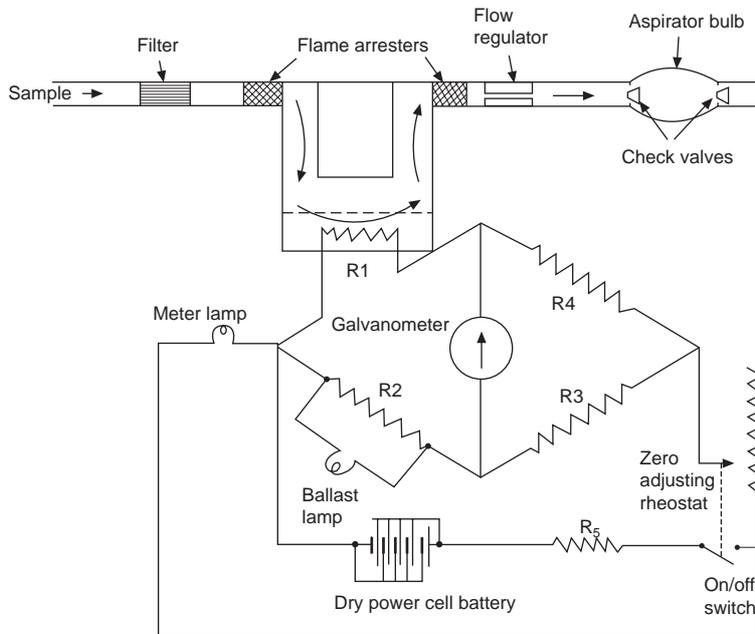


Figure 10.14 Combustion gas detector (catalytic filament type).

Guidelines for the Use of Marine Safety Card No. 1

Responsibility for safety, both at the time of entry of any tank or other enclosed space and during the entire operation, rests with the Master or responsible officer. This responsibility covers conditions of work for shore-based employees as well as for members of the ship's crew. The Master or officer makes sure that adequate steps have been taken to eliminate or control the hazards. He must also make sure that all personnel understand the nature of such hazards which remain, and the precautions to be followed.

Enclosed spaces include any tank, cargo space or compartment in which toxic inert, asphyxiating, flammable or other dangerous gases may accumulate, or oxygen may be deficient, such as:

1. Any space containing or having last contained combustible or flammable cargo or gases in bulk.
2. Any space containing or having last contained cargoes of a poisonous, corrosive or irritant nature.
3. Spaces in tankers immediately adjacent to the spaces referred to in (1) and (2) above.
4. Cargo spaces or other spaces that have been closed and/or unventilated for some time.
5. Storerooms or spaces containing noxious or harmful materials.
6. Spaces that have been fumigated.

The hazards inherent when working in an enclosed space can be avoided or overcome if the following rules are applied properly each and every time a space is entered:

1. Establish a definite system of pre-planning for enclosed space entry and a crew instruction programme.
2. Prepare the space for entry by physically isolating it, cleaning it to remove contaminants, and testing to ensure absence of such contaminants.
3. Use a checklist, backed up if necessary by a permit system. The checklist should only be issued to another crew member after the Master or responsible officer is satisfied personally with the precautions taken, personal protective equipment to be used, and procedures to be followed.

The Marine Safety Card No. 1 (Figure 10.15) serves as a method of reminding all concerned of recommended procedures and also as a checklist to ensure that all existing hazards are considered and evaluated, and, where necessary, the correct protective measures taken. It has been designed so that it may be used on board all types of ship, from the largest tanker to a small coastal vessel. Instructions and advice listed on the card are not intended in any way to take the place of other rules and recommendations on board the ship; it is intended to reinforce these. It may also be used in conjunction with a permit system, where one is employed.

It is recommended that the cards be issued only when the need for their use arises. When in use, the cards should be completed properly as instructed. Any relaxation is likely to result in diminishing respect for their use, with a resulting decline in the standards of safety achieved. In order to operate successfully, the Marine Safety Card must receive support from senior ship's personnel; the response of other crew members will obviously be influenced by this.

It may sometimes be necessary for a person to enter an enclosed space that is known to contain an unsafe atmosphere. This practice should only be allowed when it is essential or in an emergency. On no account should routine work be carried out under such conditions. Section 1 of the checklist should be completed by the Master or a responsible officer and the card should then be handed to the person who is to enter the space for completion of Section 2. Section 3 should be checked jointly by the responsible officer and the person who is to enter the space on every occasion that breathing apparatus is used.

It should be remembered that rescue and resuscitation equipment should be tested at the time of inspection and check.

The card is finished with a matt surface on the checklist side. It is recommended that a soft pencil is used to make the checks. After use the card should be cleaned with a rubber, tissue or damp cloth.

The card is issued by the General Council of British Shipping.

INERT GAS SYSTEM

The purpose of an inert gas system (Figure 10.16) is to blanket the surface of the cargo (or ballast) and prevent a mixture of air and hydrocarbons causing fire or explosion within the tank space. The gas is supplied by means of an 'inert gas generator' or extracted from 'boiler flue gases' taken from the main boiler uptakes. Remotely controlled 'butterfly valves' allow the extraction of the gas from port and starboard boiler uptakes before its entry via scrubbing tower, demister unit then water seal (Figure 10.17) before entering space.

The cooled, clean inert gas is drawn off from the scrubbing tower by conventional centrifugal fan units capable of delivering sufficient gas to replace cargo during discharge at the maximum pumping rate plus 25 per cent and to maintain a positive pressure at all times. The gas will enter the tank after passing through a 'deck-mounted water seal', which is specifically incorporated into the system to prevent hydrocarbon gases flowing back up the line. The deck water seal unit is fitted with a steam heater for operations in cold weather.

Additional safety features included in the system are a mechanically operated 'non-return valve' and a pressure/vacuum breaker fitted to prevent over or under pressurisation of the cargo tanks. (Alternatively the P/V breakers may be fitted individually to each tank.)

Venting of tanks during loading or when purging hydrocarbons is achieved by vent valves or masthead risers. As cargo levels rise during the process of loading the inert gas is vented into the atmosphere.

Figure 10.15 Marine Safety Card No. 1

MARINE SAFETY CARD No. 1

Entering Cargo Tanks, Pump Rooms, Fuel Tanks, Cofferdams, Duct Keels, Ballast Tanks of similar enclosed compartments.

General Precautions

Do not enter any enclosed space unless authorised by the Master or a responsible officer and only after all the appropriate safety checks listed on the reverse of this card have been carried out.

The atmosphere in any enclosed space may be incapable of supporting human life. It may be lacking in oxygen content and/or contain flammable or toxic gases. This also applies to tanks which have been inerted.

The master or a responsible officer **MUST** ensure that it is safe to enter the enclosed space by:

- (a) ensuring that the space has been thoroughly ventilated by natural or mechanical means; and
- (b) where suitable instruments are available, by testing the atmosphere of the space at different levels for oxygen deficiency and/or harmful vapour; and
- (c) where there is any doubt as to the adequacy of ventilation/testing before entry, by requiring breathing apparatus to be worn by all persons entering the space.

WARNING

Where it is known that the atmosphere in an enclosed space is unsafe it should only be entered when it is essential or in an emergency. All the safety checks on the reverse side of this card should then be carried out before entry and breathing apparatus must be worn.

Protective Equipment and Clothing

It is important that all those entering enclosed spaces wear suitable clothing and, that they make use of protective equipment that may be provided on board for their safety. Access ladders and surfaces within the space may be slippery and suitable footwear should be worn. Safety helmets protect against falling objects and, in a confined space, against bumps. Loose clothing, which is likely to catch against obstructions, should be avoided. Additional precautions are necessary where there is a risk of contact with harmful chemicals. Safety harnesses/belts and lifelines should be worn and used where there is any danger of falling from a height.

There may be additional safety instructions on board your ship, make sure that you know them.

Further information on safe entry into enclosed spaces is contained in the Code of Safe Working Practices for the Safety of Merchant Seamen and the ICS Tanker Safety Guides.

Issued by the General Council of British Shipping,
30–32 St Mary Axe, London, England EC3A 8ET.

SAFETY CHECK LIST

Before entering any enclosed space all the appropriate safety checks listed on this card must be carried out by the master or responsible officer and by the person who is to enter the space.

N.B. For routine entrance of cargo pump rooms only those items shown in red are required to be checked.

SECTION 1

To be checked by the master or responsible officer

- 1.1 Has the space been thoroughly ventilated and, where testing equipment is available, has the space been tested and found safe for entry ?
- 1.2 Have arrangements been made to continue ventilation during occupancy of the space and at intervals during breaks ?
- 1.3 Are rescue and resuscitation equipment available for immediate use beside the compartment entrance ?
- 1.4 Have arrangements been made for a responsible person to be in constant attendance at the entrance to the space ?
- 1.5 Has a system of communication between the person at the entrance and those in the space been agreed ?
- 1.6 Is access and illumination adequate ?
- 1.7 Are portable lights or other equipment to be used of an approved type?

When the necessary safety precautions in SECTION 1 have been taken, this card should be handed to the person who is to enter the space for completion.

SECTION 2

To be checked by the person who is to enter the space

- 2.1 Have instructions or permission been given by the master or a responsible officer to enter the enclosed tank or compartment ?
- 2.2 Has SECTION 1 been completed as necessary ?
- 2.3 Are you aware you should leave the space immediately in the event of failure of the ventilation system ?
- 2.4 Do you understand the arrangements made for communication between yourself and the responsible person in attendance at the entrance to the space ?

SECTION 3

Where breathing apparatus is to be used this section must be checked jointly by the responsible officer and the person who is to enter the space.

- 3.1 Are you familiar with the apparatus to be used ?
- 3.2 Has the apparatus been tested as follows ?
 - (i) Gauge and capacity of air supply
 - (ii) Low pressure audible alarm
 - (iii) Face mask – air supply and tightness
- 3.3 Has the means of communication been tested and emergency signals agreed ?

Where instructions have been given that a responsible person be in attendance at the entrance to the compartment, the person entering the space should show their completed card to that person before entering. Entry should then only be permitted provided all the appropriate questions have been correctly checked

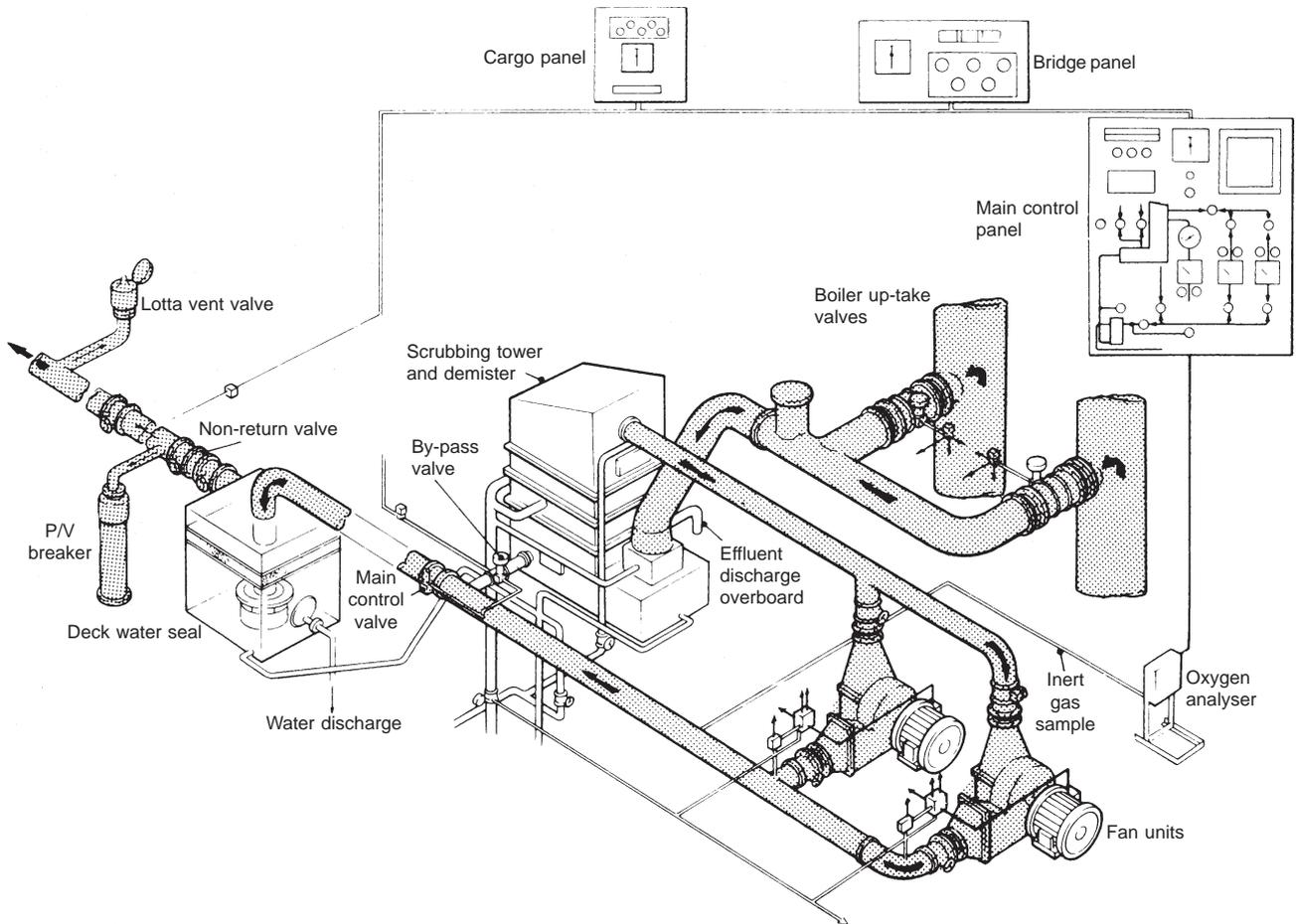
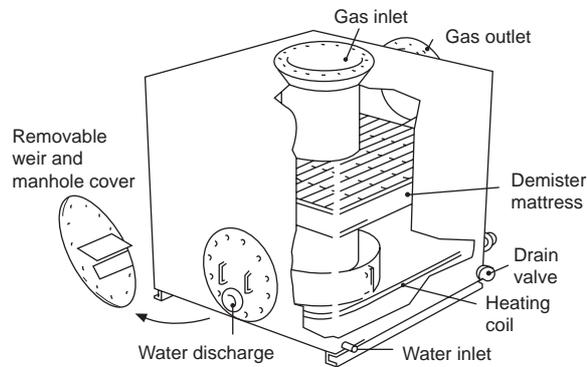


Figure 10.16 Inert gas system.

Figure 10.17 Deck mounted water seal.

This deck mounted water seal prevents hydrocarbon gases flowing back to the uptakes. This safety feature is additional to the seal in the bottom of the scrubber and the gas non-return valve in the inert deck main. Sea water is used for the water seal and it is continuously pumped into the base at 4 tons/hour, the correct level being maintained by a weir. A coarse polypropylene demister mattress is fitted above the water seal to remove any water carry-over. All internal surfaces are ebonite rubber lined, cured in situ.



Composition of Boiler Flue Gases

The average composition of flue gases employed as inert gases and obtained from main or auxiliary boilers is as follows: CO₂ 13 per cent, O₂ 4 per cent, SO₄ 0.3 per cent, the remaining percentage being made up of nitrogen and water vapour. Such a mixture will not support combustion, and is therefore suitable for use as an inert gas once it is cooled and cleaned.

Advantages

1. Safety – risk of fire and/or explosion reduced.
2. Reduced corrosion – tank corrosion is inhibited by the low oxygen content of the gas.
3. Faster cargo discharge – the increased tank pressure created during the period of discharge by the introduction of the inert gas into the tank speeds up the discharge operation.
4. Tank washing time is reduced because it is possible to wash with high-capacity fixed guns in an inert atmosphere. Crude oil washing (COW) is also possible under these conditions.

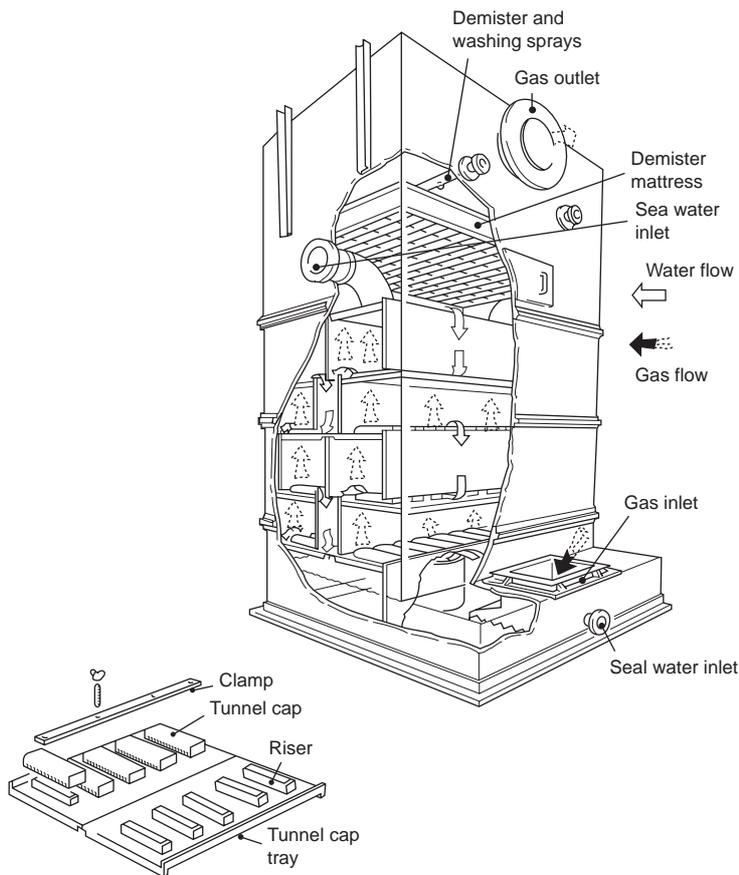


Figure 10.18 Scrubbing tower and demister.

The purpose of the scrubber is to cool and remove unwanted elements from the boiler flue gas. Water is introduced from the top of the scrubber, while the gas enters via a water seal at the bottom. This water seal also serves to cool the gas as it enters the tower. Up to 98 per cent of acids (SO₂) are removed under normal operational conditions.

5. Fresh air purging of the tanks – the system can provide large volumes of fresh air to cargo tanks very quickly, which is beneficial for maintenance and tank inspections.
6. Cheap and readily supplied (funnel exhaust gases).
7. Compatible for use with certain chemicals which react with oxygen.

Disadvantages

1. Installation cost is high initially, with additional expense incurred for general maintenance.
2. Danger to personnel due to the lack of oxygen within the tank.
3. Reduced visibility inside the tanks.
4. Additional cost of an inert gas generator required for use when main engines are not in use, e.g. when in port.
5. Danger of flammable gases returning towards the boiler if water seal and non-return valve are not properly maintained.
6. Improved purity required in inert gases for use with chemicals, i.e. need for nitrogen, with the additional expense that this purchase incurs.

MOORING LARGE TANKERS

Anchoring

The requirements of large tankers in the way of deeper water and heavier anchor equipment than other vessels have become obvious areas of consideration since the arrival of the first 100,000 DWT vessel. Now much larger tonnage, such as the VLCC and the ULCC type vessels, have appeared, further consideration is warranted.

The depth of tanker anchorages throughout the world usually range from 20 to 30 fathoms (36.6–55 m). The minimum amount of cable that a large vessel may expect to use must be considered about six times the depth of water, i.e. 120 to 180 fathoms (220–330 m), provided all other conditions are favourable. Since the length of chain cable required by the Classification Society is 351 m for the largest ships, it can be seen why Masters are reluctant to use anchors.

In all fairness to the shipowners the majority have equipped their vessels with adequate reserves of cable, and it is not uncommon for vessels to carry 15 shackles (450 m) chain cable on each anchor. If conditions were such that ten times the depth of water would be an appropriate amount of cable to use, this would limit the vessel to anchoring inside depths of 45 m.

Having considered the amount of cable to be used in anchoring, mariners should look at any weak links in the system. They do exist, and are encountered usually at the windlass with the braking system, or at the anchor itself with respect to its holding power.

Most of the information regarding the anchor arrangements for large vessels has come from experience gained on smaller vessels. In many respects the experience has been transferable, but in other areas new concepts of safe handling have had to be developed. Controlling the

speed of a running cable by use of a band brake on the windlass is no longer acceptable. The momentum achieved, say, by a 15 tonne anchor with added weight of cable, free running, is too great to handle.

In order to control the great weights of anchor and chain, the chain velocity and the consequent friction, hydraulically operated braking systems have now been devised. The modern designs are such that the faster the cable runs, the greater the pressure created on the braking system. Other commercially available systems employ disc brakes and limit switches governing the speed of the windlass.

Types of Anchor

There are many types of anchor presently in use aboard most kinds of larger vessel, not just large tankers. Various weights of anchors with different sizes of cable have been tried and tested in all conditions over the last few years. The AC 14 anchor, popular not only with warships but also with large passenger liners, would appear to be the most suitable to combat the kinetic energy of, say, a ULCC moving slowly over the ground.

Seafarers engaged in the mooring of large vessels will no doubt be aware of the many variables which could affect the operation before the 'brought up' position is reached. The holding ground, weight of chain and the weight of the anchor itself will influence the time that the anchor is dragging before it starts to hold, assuming that the anchor does not become snagged or hung up on a rocky bottom.

The old idea that the amount of cable paid out is what holds the vessel is still true for VLCCs and ULCCs, but vessels fitted with an anchor of high holding power will have a distinct advantage. Masters and berthing pilots should be wary once the anchor has held, especially one of good holding power, of the possibility of parting the chain cable by excessive ship-handling movements. The problem is accentuated when the external uncontrollable forces of current, wave motion, and wind are present in a manoeuvring operation.

If the berthing situation is one where anchors may be used, full consideration of their use should be made before the operation is executed. Prudent use of tugs' mooring lines, bow thrust units, main engine propulsion, and an efficient mooring launch will undoubtedly help in ship-handling operations with this type of vessel.

Mooring Systems

Offshore terminals where tankers of all sizes are required to load and discharge via single point moorings (SPMs) are now an accepted fact of the oil tanker trade. Complete rope assemblies for securing to an SPM are commercially available, and they are made to provide not only maximum strength but also a high energy absorption capacity to counteract heavy and repeated loadings. The general design may vary to take chafe into account either at the buoy end or at the vessel's 'pick up' end. Vessels are very often fitted with purpose-built bow stoppers for accepting the fairlead chains. Failing this, tankers are secured by nylon braidline strops

or flexible (6×36) galvanised steel wires turned directly on to bits (see Figure 10.19).

OIL POLLUTION

This subject is presented under the following headings:

1. Loading/discharging of bulk oil.
2. Compulsory insurance for vessels carrying persistent oil in bulk.
3. Reception facilities for oily waste.
4. Reporting of pollution incidents.
5. Penalties and offences with regard to oil pollution incidents.
6. Prevention of oil pollution.
7. The prohibition of oil discharges into the sea from ships.
8. Resumé of existing oil pollution regulations and what can be expected for the future.

Loading and Discharge of Bulk Oil

The Master of any vessel is finally responsible for the correct loading and safe carriage of his cargo. However, it is accepted practice that his responsibilities are delegated to ships' officers, the 'chief officer' being generally given that of cargo operations officer for the vessel.

Loading of cargoes is expected to comply with all provisions of the stability booklet. The slack tanks should be noted and kept below the limiting number. Free surface build-up in slack tanks in the past has sometimes made the vessel 'unstable' while loading or discharging. Should any abnormal list develop during loading, oil cargo may overflow. This

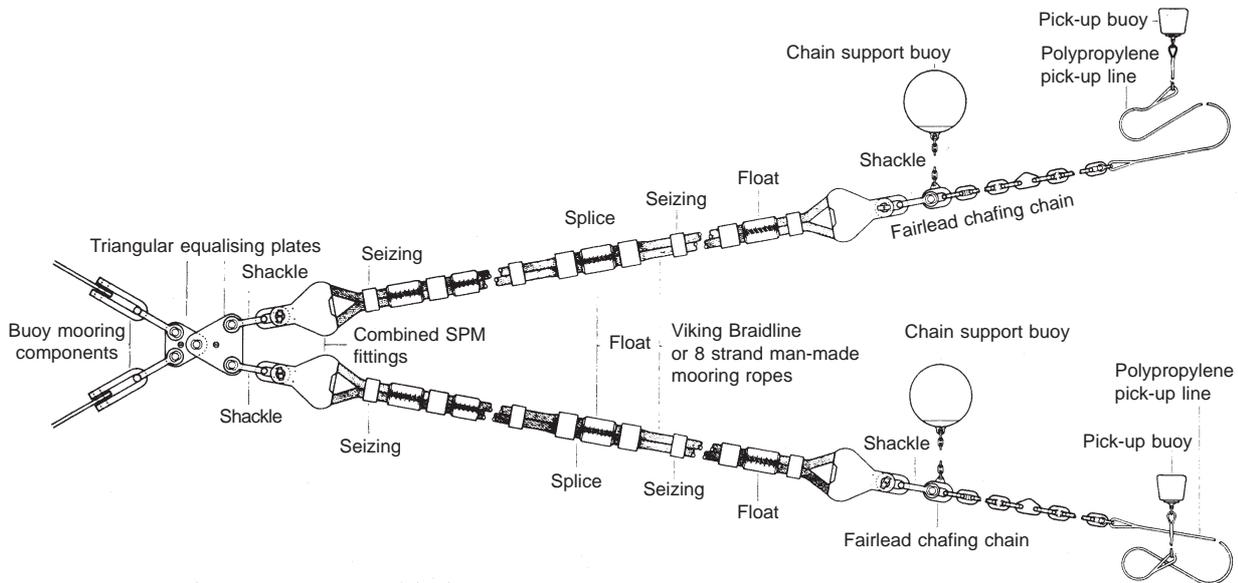


Figure 10.19 Typical mooring system used by buoy operators in a conventional single point mooring.

undesirable situation could be exacerbated by an imbalance in the quantity of water in ballast tanks, the combined effect of free surface in too many tanks and the added free surface effect from partly filled fresh water and ballast tanks.

Cargo officers will require the following information when about to load bulk oil:

1. Cargo specifications and special characteristics, e.g. lead content.
2. Loading temperatures, together with flashpoints and specific gravity of oil.
3. Nominated quantities and tank order of loading.
4. Maximum shore loading rate and maximum back pressures at the manifold.
5. Communication system and emergency stop arrangements.
6. Number of hoses to be employed, with their respective size for each grade of oil.
7. Loadline figures for bunkers, boiler feed, stores etc. to ensure that the vessel's draught conforms to loadline regulations when passing through the various 'zones'. (These calculations will determine quantity of cargo loaded.)

The terminal will require the following information:

1. Types of previous cargoes carried, and the method of tank cleaning employed.
2. Maximum loading rate and topping off rate that the vessel can handle.
3. Maximum back pressures at the manifold.
4. Cargo loading plan, tank disposition and cargo quantities.
5. Order of loading or discharging.
6. Quantity of ballast for discharge and quantity of slops (oily waste), together with their disposition.
7. Method of venting. Precautions against static.
8. Cargo specifications and ballast time for the vessel.

The cargo officer should take the following precautions against accidental oil spillage or leakage:

1. See moorings are tended throughout operations, and hose lengths sufficient to allow for ranging. Close off all valves not in use.
2. Carry out regular checks on cargo tanks, especially during the topping off period.
3. Plug scuppers before starting, draining off any excess water.
4. Provide drip trays at the manifold.
5. Blank off all lines and connections not in use.
6. Draw up contingency plans in the event of spillage.

In the event of spillage, e.g. a burst hose length, proceed as follows:

1. Stop all cargo operations. Sound the alarm.
2. Prevent oil or vapour entering the engine room.
3. Inform harbour authority, terminal manager, and adjacent shipping.

SOPEP – Ships Oil Pollution Emergency Plan,
Ref. MGN 110.

4. Enter details of the incident into the oil record book.
5. Close access doors and shut down ventilation systems.
6. Consult spillage contingency plans (SOPEP).

The following pump-room precautions should be taken:

1. Avoid loading through the pump room.
2. Ensure that all drain plugs and strainer covers etc. are secure before loading.
3. Inspect pump glands regularly for leakage and the overheating of bearings.
4. Test level alarms before they are employed.

Transfer of oil from a vessel while in port cannot be undertaken before the following procedure is carried out:

1. Written permission must be obtained from the harbourmaster. In some ports the vessel may have to be moved to a special berth before permission will be granted.
2. Port by-laws must be observed at all times.
3. All overboard discharges must be secured when connected to oil transfer pumps before transferring takes place.

Compulsory Insurance

Insurance regulations are laid down by the International Convention on Civil Liability for Oil Pollution Damage, 1969, which came into force from 19 June, 1975, and the Merchant Shipping Act (Oil Pollution), 1971, as amended by section 9 of the Merchant Shipping Act, 1974. The regulations state that a vessel of whatever registry, when carrying more than 2000 tons of persistent oil, shall not be allowed to enter or leave a port in the United Kingdom without a certificate of insurance (or other financial security). This also applies to UK ships entering any other country's territorial waters with more than 2000 tons of persistent oil, in bulk, as cargo.

Non-persistent oils include motor spirit, kerosene and the lightest fractions of the refining process. If they were to be deposited close to a coastline they might contribute to pollution of the beach areas, but if deposited at a reasonable distance out at sea they evaporate or otherwise disappear.

Animal and vegetable oils are assimilated by the sea water or physically by animal life within the sea water.

Whereas a *persistent oil* will not break down with sea water, and remains for indefinite periods floating on the surface. The mineral oil derivatives most likely to cause contamination were fuel oils and waxy crude oil waste, together with diesel. These particular grades when discharged at sea did not dissipate completely, but left a 'film' over the surface which gradually coalesced to form thick rubbery lumps of lower specific gravity, than that of sea water. The lumps floated, as with tide, winds and currents.

Persistent and non-persistent oils are graded by the authorities with

relation to the nuisance value of the type of oil when mixed with sea water.

Certificates are issued by the government authority of the country whose flag the vessel sails under. In the United Kingdom the certifying authority is the Department of Trade, Insurance Division. Satisfactory evidence must be produced to the certifying authority for the issue of the certificate. Non-compliance with the regulations for obtaining a certificate of insurance (or being covered by financial security) may cause the vessel to be detained or fined or both, when the fine would not exceed £35,000.

Reception Facilities for Slops

Dirty ballast and oily waste are the main constituents of slops and the main problem in pollution control. From the early days of pollution control it has been the responsibility of the oil companies or the tankers themselves to solve the problem of dealing with waste products.

Many ports have now established reception facilities for slops, but there are as many without such means. To offset the immediate problem, tankers allocate one or more of their cargo tanks for the storage of waste products. This temporary storage lasts only until the vessel is able to pump the contents of the 'slop tank' ashore into purpose-built receptacles.

During tank washing procedures, the oily waste rises to the surface, leaving clean (relatively oil-free) water underneath. The pumping of this water via an oily water separator certainly eases and reduces the problems of volume in the slop tanks. The problems of wax and sludge remain and have to be handled by shoreside facilities.

Waste may be classified as follows:

- (a) Dirty ballast water.
- (b) Tank washing residues.
- (c) Sludge and scale (from tank-cleaning operations).
- (d) Oily mixtures contaminated by chemical cleansing agents.
- (e) Contaminated bilge water.
- (f) Sludge from purification of fuel or lubricating oils.

Signatories to the Convention for the Prevention of Oil Pollution have established a reporting scheme whereby Masters of vessels may enter a report on port facilities. Reports on reception facilities for oily waste products should be submitted to the shipowner and then forwarded to the national administration (in the UK the Department of Trade). MGN 82 (M + F) gives further details.

Reporting of Pollution Incidents

Oil spillage reporting arrangements have been practised by UK registered vessels for some considerable time but the Marine Environment Protection Committee of IMO has recently applied the reporting scheme to cover spills of substances other than oils.

Masters and other observers should report any of the following:

1. An accident in which actual spillage of oil or other harmful substance occurs, or may occur.
2. Any spillage of oil or other harmful substance observed at sea.
3. Any vessel seen discharging oil in contravention of the International Convention for the Prevention of Pollution Regulations 1983–85.

Such incidents or slicks which may affect coastlines or neighbouring states should be reported to the nearest coast radio station. In the United Kingdom reports should be directed to the coastguards, via the coast radio station. Pollution reports should be made as quickly as possible and in plain language. To the Marine Pollution Control Unit (MPCU) of the MCA.

They should contain the following information:

- (a) Name of the reporting ship.
- (b) Name of the ship, if known, causing the pollution (whether or not this is the reporting vessel).
- (c) Time and date of the incident or observation.
- (d) Position of the incident or observation.
- (e) Identity of the substance, if known.
- (f) Quantity of spill (known or estimated)
- (g) Wind and sea conditions.

Penalties and Offences

Under the United Kingdom Merchant Shipping Act, 1979, and the Merchant Shipping (Oil Pollution) Act 1971, as amended, the owner or Master of a ship from which oil has been illegally discharged into the sea is liable, on summary conviction, to a fine not exceeding £50,000, or on conviction on indictment to a fine.

The shipowner can limit and escape liability if he is not at fault and can prove that the discharge was:

- (a) Through an act of war or natural phenomenon beyond his control.
- (b) Any other person, causing damage or intending to cause damage, who is not employed by the company or an agent of the company, was responsible. (This covers the shipowner against terrorist and such like activity.)
- (c) Due to any authority not maintaining navigational equipment to the proper specifications.

The owner can limit liability to approximately £56 per ton, of the vessel's tonnage or approximately £5,800,000, whichever is the least. Should the shipowner be at fault, then he cannot limit his liability.

For many offences under the Merchant Shipping Act the fines incurred range from £50 to £1000 on summary conviction of the offence, together with an unlimited fine and imprisonment on conviction on indictment.

As regards insurance, the carriage of more than 2000 tons of persistent oil in bulk as cargo without valid insurance or other valid financial

NB. Since the ExxonValdez pollution incident in Alaska (1989) ship owners have not been allowed to limit liability in the event of oil pollution accidents.

security is an offence. The penalty on summary conviction is a fine not exceeding £35,000 and possible detention of the ship.

It is also an offence if the Master fails to produce a certificate of insurance. He is liable on summary conviction to a fine not exceeding £400.

Should a vessel fail to carry a certificate of insurance, then the Master of the vessel is liable on summary conviction to a fine not exceeding £400.

If a person directed by the regulations fails to deliver a certificate of insurance (surrender the certificate to the correct authority), then that person is liable on summary conviction to a fine not exceeding £200.

Regarding the movement of oil, vessels are required to be fitted with items of equipment that prevent the discharge of oil into the sea. Such equipment must comply with the standards specified in the Oil in Navigable Waters Act. Should these provisions be contravened the owner or the Master of that vessel is guilty of an offence. The penalty on summary conviction is a fine not exceeding £1000, or on indictment to a fine.

Transferring oil at night may be an offence. No oil should be transferred at night between sunset and sunrise to or from a vessel in any harbour in the United Kingdom unless the requisite notice has been given in accordance with the Oil Pollution Act, or the transfer is for the purposes of the fire brigade. On summary conviction the offender is liable to a fine not exceeding £100.

Failure to report a discharge of oil is an offence. It is the duty of the owner, Master or occupier of the land about which a discharge of oil occurs to report such discharge. Any person so concerned who fails to make such a report is guilty of an offence, and on summary conviction to a fine not exceeding £200.

Failure to comply with instructions from the Secretary of State, or his designated agent to avoid pollution from the result of a shipping casualty is an offence. Should any obstruction occur, the person causing that obstruction, on summary conviction may be subject to a fine not exceeding £50,000, or on conviction on indictment to a fine.

Failing to carry an oil record book, as required by the regulations, is an offence, and the owner or Master shall be liable to a fine not exceeding £500 on summary conviction.

Failure to keep proper records is an offence, subject on summary conviction to a fine not exceeding £500 for the person who is responsible.

Deliberately making a false or misleading entry in the oil record book or in any other similar records is an offence. The penalty on summary conviction is a fine not exceeding £500 or imprisonment for a term not exceeding six months, or both, or on conviction on indictment to a fine or to imprisonment for a term not exceeding two years or both.

Failure to produce the oil record book is an offence, subject on summary conviction to a fine not exceeding £10.

Any person who obstructs the duty of an inspector who is acting with the power of inspection concerning oil records, is guilty of an offence. He is liable on summary conviction to a fine not exceeding £100.

It is a requirement for records to be retained for a minimum period of two years by the authority designated by the regulations. If those responsible for the custody of records fail in this duty, they may be liable on summary conviction to a fine not exceeding £500.

Prevention of oil Pollution

Regulations from IMO now specify the installation of oily water separators aboard all non-tanker type vessels over 400 gross tons. There are many types of oily water separators available, each providing clean water discharge well below the 15 parts per million of oil in water requirement.

Depending on size, capacity will vary with the model being used, from 0.5 cu.m per hour up to 60 cu.m per hour. The primary purpose of oily water separators is to prevent pollution, but the value of the recovered oil should not be overlooked.

The *Torrey Canyon* disaster in March 1967 demonstrated the need for pollution control and increased research into prevention methods. It also highlighted the need for new ideas and methods of containment in pollution incidents.

The enclosure of any spillage by use of some form of barrier was widely investigated and subsequently tried. Some degree of success was achieved when small spillages were encountered and good weather prevailed at the time. However, over large areas the time required to establish the barrier was found to be excessive, and barrier equipment needed to encircle a large area would not always be readily available. The controlling factor in the containment of oil spillage by a floating barrier is undoubtedly the weather.

Strong detergents have been tried on many occasions in 'clean-up operations' after spillage has occurred. The main disadvantage of this method is that the detergent used must be effective in breaking up the oily substance quickly, but very few achieve this result. Large quantities of detergent are required and the cost of using this method is high. Difficulties also arise with dispensing detergent over a wide area and achieving full coverage.

One would think, after the many lessons that have been given, it would be found cheaper and more practical to train personnel and equip modern ships to prevent pollution occurring in the first place. However, the consequences of collision or accident will always need to be dealt with by external agencies.

Prohibition of Oil Discharge into the Sea from Ships

With certain exceptions no discharge of oil into the sea may take place within the territorial waters of the United Kingdom. This applies to ships of any flag. It is also forbidden for ships registered in the United Kingdom to discharge oil into the sea anywhere else in the world.

Notable exceptions are as follows:

- (a) Vessels of less than 80 gross registered tons may discharge from their bilges while they are in UK territorial waters a mixture in

which the only oil is lubricating oil which has drained or leaked from machinery spaces.

- (b) A harbour authority may appoint a place within its jurisdiction where ballast water of vessels in which a cargo of petroleum spirit (as defined by regulations) has been carried may be discharged into the waters of the harbour, at such times, and subject to such conditions, as the authority may determine.

In the event of proceedings being brought against the owner or Master of a vessel, special defences may apply in the following circumstances:

1. If it can be proved that any discharge was made for the purpose of securing the safety of any vessel, of preventing damage to any vessel or cargo, or of saving life.
2. If it can be proved that the discharge occurred in consequence of damage to the vessel, and that as soon as practicable after the damage occurred all reasonable steps were taken for preventing or (if it could not be prevented) for stopping or reducing the escape.
3. If it can be proved that the escaped oil or mixture was caused by reason of leakage, that neither the leakage nor any delay in discovering it was due to any want of reasonable care, and that as soon as practicable after the escape was discovered all reasonable steps were taken for stopping or reducing the leak.

Resumé of Oil Pollution Regulations

The question of pollution has become politically sensitive not just in the marine field but also in the atomic field. The protection of the environment has become the concern of all responsible persons, and rightly so. However, society demands improvements in living standards, and these demands have created their related problems, e.g. pollution.

Without doubt control of oily water mixtures, garbage nuclear waste etc. will be tightened up so that no pollution of the environment will be allowed to take place. This situation will be a long time coming but it is by no means out of reach.

It must be expected that existing legislation, namely the Oil in Navigable Waters Act and Prevention of Oil Pollution Act, will be reviewed and tighter control with stiffer penalties for offenders become the order of the day. More countries will become signatories of the 1954 Convention for the Prevention of Oil Pollution and eventually the responsibility for preventing pollution will be accepted by all nations.

In 1973 a second convention was adopted at a conference in London, attended by 71 nations. The regulations set down, and subsequently reviewed in 1978, are known as Marpol regulations, for which the target date for enforcement was June 1981. (Additional amendments to Marpol 1988, 1991, 1995. Inclusive of garbage regulations.)

The following are some of the main points:

1. Oil means crude, fuel oil, lubricating oil, petrol, kerosene, naphtha etc.

2. Tonnages are gross registered tons and *not* deadweight tonnes.
3. The regulations will apply immediately to new ships, i.e. vessels delivered to owners after 31 December, 1979, and vessels undergoing major conversion completed after 31 December, 1979, and will apply to existing ships by 2 October 1986.
4. All ships of 400 GRT or more, if less than 10,000 GRT, should be fitted with an oily water separator or filter, achieving not more than 100 parts per million; and if 10,000 GRT or more should be fitted as above plus the following:
 - (a) a monitoring system which comes into operation when there is any discharge of effluent, e.g. fluid left after settling for a number of days.
 - (b) a control system such that any discharge of oily mixture is automatically stopped when the oil content of the effluent exceeds 100 ppm, plus an audio visual alarm.

Failure of either monitoring or control systems would cause the immediate stopping of the operation, the event being noted in the oil record book. Existing ships may manually stop discharge when the ppm alarm is activated.

5. If the ship chooses not to have a monitoring and control system, she shall be fitted with an oily water separator whose effluent is not more than 100 ppm, and pass this effluent to an oil filter system that will produce an effluent whose oil content does not exceed 15 ppm and is fitted with an alarm to indicate when this level cannot be maintained.

Even when this degree of cleanliness is achieved, the ship must be more than 12 miles from land, or be proceeding en route, i.e. she cannot leave a dock to dump then return to port. Every ship is to be provided with tanks of adequate capacity to receive oil residues (sludge) from purification processes (oil leakages etc.) until such time as it can be received ashore.

Pollution References

'M' NOTICES (CURRENT - SEPTEMBER 2000)

- 700 Oil pollution prevention on tankers, separation of cargo oil piping system from the sea.
- 1196 Marine pollution - manual on oil pollution.
- 1197 The Merchant Shipping (Prevention of oil pollution) Regulations, 1983 - Additional recording and documentation for oil record books.
- 1273 Control of pollution by noxious liquid substances in bulk-implementation of Annex II to MARPOL 1973/1978 (with amendment)
- 1374 Oil pollution - compulsory insurance.
- 1438 The Merchant Shipping (Control of Pollution by Noxious Liquid Substances in Bulk) (Amended) Regulations, 1990.
- 1447 The merchant Shipping (Control of Pollution by Noxious Liquid Substances in Bulk) Regulations, 1987 (as amended), Surveys and related matters.
- 1577 Extension of strict liability of shipowners for oil pollution damage.
- 1589 The Merchant Shipping (IBC code) (BCH code) Regulations, 1994 and the (Control of Pollution by Noxious Substances in Bulk) (Amendment) Regulations, 1994.
- 1614 Standard format and procedures for ship reporting, including dangerous goods, harmful substances and/or marine pollutants.
- 1643 MARPOL 1, Notice to shipowners, Masters, Certifying Authorities and Surveyors.
- 1678 (M+F) The Special Waste Regulations, 1996.
- 1703 (M) The Merchant Shipping (Dangerous or Noxious Liquid Substances) Regulations, 1996.
- 1709 (M+F) Port Waste Management Plans.
- 1720 (M+F) Merchant Shipping (Prevention of Pollution by Garbage) Regulations, 1998
- 1741 (M) Reporting requirements for ships carrying dangerous or polluting goods.
- MGN 33 (M+F) Sewage systems on ships associated hazards, installation and maintenance.
- MGN 37 (M) The Merchant Shipping (dangerous goods and marine pollutants) Regulations, 1997.
- MGN 79 (M+F) Safety Equipment and Pollution Prevention Equipment Carried in Excess of Statutory Requirements.
- MGN 81 (M+F) Guidelines for the Control and Management of Ships Ballast Water to minimize the Transfer of Harmful Aquatic Organisms and Pathogens.
- MGN 82 (M+F) Inadequacy of Reception Facilities for Oil Residues and Mixtures Noxious Liquid Substances and Garbage.
- MGN 110 (M+F) Shipboard Oil Pollution Emergency Plans.
- MGN 142 (M+F) MARPOL 73/78 - ANNEX VI: Control of Emission of Nitrogen Oxides (Nox) From marine diesel engines.
- MGN 143 (M+F) MARPOL 73/78 - ANNEX VI: Standards/Certificates Related to shipboard Incineration of Waste.

MGN 145 (M)	Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations, S.I. 1997/2367.
MIN 42	Merchant Shipping (Prevention of Oil Pollution) Regulations, 1996. Arrangements for Survey and Certification, S.I. 1996/2154.
MIN 57	Merchant Shipping (Dangerous or Noxious Liquid Substances in Bulk) Regulations, S.I. 1996/3010.

APPENDIX TO CHAPTER 10

*Contracting Governments to the 1954 Convention,
as amended up to 1969*

The Democratic and Popular Republic of Algeria
The Argentine Republic
The Commonwealth of Australia
The Republic of Austria
The Commonwealth of the Bahamas
The Kingdom of Belgium
The People's Republic of Bulgaria
Canada
The Republic of Chile
The Republic of Cyprus
The Kingdom of Denmark
The Dominican Republic
The Arab Republic of Egypt
Fiji
The Republic of Finland
The French Republic
The German Democratic Republic
The Federal Republic of Germany
The Republic of Ghana
The Revolutionary People's Republic of Guinea
The Hellenic Republic
The Republic of Iceland
The Republic of India
The Republic of Ireland
The State of Israel
The Italian Republic
The Republic of the Ivory Coast
Japan
The Hashemite Kingdom of Jordan
The Republic of Kenya
The Republic of Korea
The State of Kuwait
The Lebanese Republic
The Republic of Liberia
The Socialist People's Libyan Arab Jamahiriya
The Democratic Republic of Madagascar
The Republic of Malta
The United Mexican States
The Principality of Monaco
The Kingdom of Morocco
The Kingdom of the Netherlands
New Zealand
The Federal Republic of Nigeria
The Kingdom of Norway
The Republic of Panama
The Independent State of Papua New Guinea
The Republic of the Philippines
The Polish People's Republic
The Portuguese Republic

The State of Qatar
The Kingdom of Saudi Arabia
The Republic of Senegal
Spain
The Republic of Surinam
The Kingdom of Sweden
The Swiss Confederation
The Syrian Arab Republic
The Tunisian Republic
The Union of Soviet Socialist Republics
The United Kingdom of Great Britain and Northern Ireland
The United States of America
The Oriental Republic of Uruguay
The Republic of Venezuela
The Yemen Arab Republic
The People's Democratic Republic of Yemen
The Socialist Federal Republic of Yugoslavia

Territories to which the 1954 Convention has been extended

Bermuda
Netherlands Antilles
Puerto Rico, Guam, US Virgin Islands, American Samoa, the Trust Territory of
the Pacific Islands, the Midway Islands, Wake Island and Johnston Island

APPENDIX

SEAMAN'S SELF-EXAMINER



The headings indicate the examinations to which the following questions and answers are directed.

OFFICER OF WATCH CERTIFICATES (ORAL)

1. **Qu.** What are the three main adjustable errors applicable to the marine sextant?
Ans. 1. Adjustment for the error of perpendicularity.
2. Adjustment for side error.
3. Adjustment for index error (parallax).
2. **Qu.** What types of anchor would you consider to be of high holding power?
Ans. A.C. 14, Flipper Delta or Bruce.
3. **Qu.** What is contained in the *Weekly Notices of Mariners*?
Ans. An index to all chart corrections effective in that issue, temporary and preliminary notices, corrections to charts, corrections to light lists, and corrections to radio signal lists, corrections to admiralty sailing directions and navigational warnings.
4. **Qu.** If a liquid magnetic compass was said to be 'dead beat', what would you understand from this statement?
Ans. That the card was steady and did not oscillate easily with the ship's movement.
5. **Qu.** How would you remove an air bubble from a liquid magnetic compass?
Ans. Turn the compass bowl on its side, in the gimbal arrangement, the expansion chamber uppermost.
Unscrew the expansion chamber and top up the fluid with a clear alcohol spirit, e.g. gin. (Surgical spirit should not be used as it will only cloud the mixture.)
6. **Qu.** How many rocket line throwing apparatus would you expect a Class VII vessel to carry on board? What is the distance

that each line throwing apparatus must be able to cast the line?

Ans. Four self-contained line throwing units. Each unit contains 275 m of line, but the specification must be such that each line throwing apparatus is capable of 230 m.

7. **Qu.** List your actions as officer of the watch when the vessel is secured alongside in harbour and a fire is discovered in Number 2 hold of a general cargo vessel?

Ans.

1. Raise the alarm (stop cargo operations, if working).
2. Call the local fire brigade.
3. Ensure that no persons are in the hold and batten down as soon as practical, closing off ventilation.
4. Remove all non-essential personnel from the vessel.
5. Start boundary cooling.
6. Assess the situation, by internal inspection if appropriate.
7. Advise the harbour authority as soon as possible.
8. Assemble damage control and fire parties and attempt to restrict and control the fire.
9. Have ship's personnel at the head of the gangway to act as guides for the local brigade.
10. Obtain fire documents, plans etc. (fire envelope).
11. Check fire wires, forward and aft.
12. Stand by main engines.

8. **Qu.** When joining a new ship as a watch officer, what would you check with regard to ship's radar?

Ans. Operate the performance monitor to ensure that the radar set was functioning correctly. Check blind sector arcs, and familiarise yourself with all the controls of the set, before getting under way.

9. **Qu.** How would you stow 2000 drums of corrosive as deck cargo, all in one batch or in small groups at various places on the deck? Explain your answer.

Ans. Stow the drums of corrosive in smaller separate groups. This type of stowage will allow easy inspection during the voyage. Leaking drums will be accessible and can be disposed of.

10. **Qu.** Explain how you would rig up a slip wire to a mooring buoy in the forepart of your vessel.

Ans.

1. Flake the slip wire on deck to allow free running.
2. Seize the eye of the wire to allow it to pass through the ring of the mooring buoy.
3. Secure the forepart by head lines to steady the bow, before running the slip wire.
4. Lower the slip and a messenger down to a mooring boat.
5. Check that the men in the mooring boat have lifejackets, especially the man who intends to 'jump the buoy'.
6. Pass the seized eye of the slip through the ring of the buoy.

7. Secure the messenger.
8. Allow the mooring boat to clear the buoy area, then heave away on the messenger to recover the ship.
9. Turn up the slip by figure eight on the bitts.

(Don't place the eyes of the wire over the bitts)

When running out, allow some slack on the slip and the messenger, to be coiled in the stern of the mooring boat.

11. **Qu.** When you are beaching a lifeboat, what signal would the coastguards send in the morse code to indicate they do not want you to make a landing?
Ans. 'S'.
12. **Qu.** What would you, as OOW, tell lookouts to watch for when searching for a life raft at night by means of searchlights?
Ans. (a) The white light on the outer canopy.
(b) The pyrotechnics – six hand-held flares, four rocket parachute flares.
(c) A flashing torch.
(d) The retro-reflective tape on the outside of the canopy.
(e) The orange hue given off by the canopy colour.
13. **Qu.** What is stowage factor?
Ans. The average cubic space occupied by 1 tonne of cargo.
14. **Qu.** How would you find the size of your anchor cable and what instrument would you use?
Ans. Measure the diameter of the bar from which the link is made by means of callipers.
15. **Qu.** If you are forced to cross over fishing nets, explain how you would do this and what precautions you could take?
Ans. Cross over the nets at right-angles to spend as little time over them as possible. Alter the ship's course to pass between fishing buoys, if seen. Call the Master in plenty of time and stop the ship's propeller as the vessel passes over the nets.
16. **Qu.** What are the characteristics of the stern light of a power-driven vessel which is more than 50 m in length?
Ans. Range not less than 3 miles, arc of visibility 135° (12 points of the compass), and positioned at or near the stern.
17. **Qu.** What is the day signal for a vessel proceeding under sail and power?
Ans. A black cone, apex, down, exhibited in a place where it can best be seen.
18. **Qu.** What is the minimum recommended safe passing distance off an oil rig. Indicate where you would obtain this information?
Ans. 500 m. *Annual Summary of Notices to Mariners or in the Mariners Handbook.*
19. **Qu.** To which vessels do the 'collision avoidance rules' apply?
Ans. All vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels.
20. **Qu.** Give the day signal, together with its size, for a vessel constrained by its draught?

- Ans.** A black cylinder having a diameter of not less than 0.6 m and a height twice its diameter.
21. **Qu.** What are the recommended safe passing distances off a mine clearance vessel engaged on mine clearance duties?
- Ans.** 1000 m. Mariners are advised to give as wide a berth as possible.
22. **Qu.** Under Rule 35 (g) a vessel aground may sound an appropriate whistle signal, in addition to her normal fog signal. What would you suggest as an appropriate whistle signal in this context?
- Ans.** International Code signals 'U' or 'L' to mean: 'U' 'You are running into danger', or 'L' 'You should stop your vessel instantly'.
23. **Qu.** You are aboard a power-driven vessel and approaching a pilot station. You do not require a pilot. What orders and instructions would you give as officer of the watch?
- Ans.** Instruct lookouts to be watchful for small pilot cutters in the area. Reduce your own vessel's speed to avoid 'swamping' any small boats in the vicinity. Make an entry in the log book, recording the reduction of speed as the vessel passes through the area. Advise the pilot station by VHF that you are passing through and do not require a pilot.
24. **Qu.** A vessel at anchor is engaged in underwater operations. What would be its 'fog signal'?
- Ans.** One prolonged blast followed by two short blasts on the whistle, at intervals of not more than two minutes.
25. **Qu.** What does the two-flag hoist 'YG' signify?
- Ans.** 'You appear not to be complying with the traffic separation scheme'.

CLASS 2 CERTIFICATES OF COMPETENCY (ORAL)

1. **Qu.** As chief officer of a vessel, what action would you take on receiving orders to proceed to 'drydock' when the vessel still has 500 tonnes of Scotch whisky aboard, stowed in Number 1 lower hold?
- Ans.** Make immediate arrangements for a lock-up stow of the cargo. Ensure that the drydock authorities are informed of the cargo in order for additional shores or blocks to be positioned to compensate for stress. Order a special nightwatchman for the period of drydock. Maintain regular fire patrols within the hold area, to guard against pilferage and any other damage to the cargo.
2. **Qu.** What is the period of validity of the following certificates: De-rat certificate, ship construction certificate, lifesaving appliance/equipment certificate (cargo ships), and cargo safety radio telegraphy certificate?
- Ans.** De-rat, 6 months.

Safety construction, not more than 5 years.

Safety equipment, not more than 2 years.

Safety radio, 1 year.

3. **Qu.** A fire is discovered in the engine room of a vessel at sea. After attempting to fight the fire by conventional means, it is decided to inject 'bulk CO₂'. Describe your actions as officer in charge in order to activate the carbon dioxide flood system.

- Ans.**
1. Order the fuel and boilers to be closed down within the engine room. (Close off all ventilation if not already done.)
 2. Evacuate the engine room of all personnel.
 3. Carry out a roll call or head count of all personnel.
 4. Check the amount of CO₂ gas to be injected, by comparison with the planned injection information. (This plan is usually displayed on the bulkhead of CO₂ room.)
 5. Open the firing cabinet door, causing the alarm to activate.
 6. Operate the firing handle/mechanism to fire the pilot bottles.

Some flood systems may require a valve to be activated to allow the gas access into the space.

4. **Qu.** After a collision at sea, the order to abandon ship is given. What would you check crew and passengers for, once they are mustered at their respective boat stations?

- Ans.** All duty officers in charge of boats and all cox'ns would be instructed to ensure that all persons are adequately clothed and that lifejackets are properly secured. A complete muster list must be taken for each boat or craft.

5. **Qu.** As officer of the watch on a vessel at anchor, you discover that another vessel is dragging its anchor and is in fact dragging down towards your own vessel. What sequence of actions would you expect to go through?

- Ans.**
1. Order main engines ready for immediate use.
 2. Order an anchor party to stand by forward.
 3. Sound five or more short and rapid blasts on the ship's whistle.
 4. Inform the Master of the situation immediately.
 5. Draw the attention of the vessel dragging her anchor by calling up on the VHF.
 6. Additionally, call attention to the situation by use of the Aldis Lamp.
 7. Stand by to (a) pay out more cable, (b) heave away on the cable and move the vessel forward, (c) go ahead on engines and steam over your own cable, and (d) provide the vessel with a sheer, by a hard over action of the rudder.

8. Have a man stand by the wheel.
9. See that an entry of events is made in the log book.
10. Make full use of international code flags during the hours of daylight.
6. **Qu.** When working two 5-tonne derricks in 'union' purchase' rig, what particular safety aspects would you warn a junior officer to take account?
- Ans.** All winch drivers should be seen to be competent and responsive to the hatch controller. Derricks should be plumbed correctly and all guys and preventers should be rigged in a proper manner. All shackles employed on the rig are to be moused and within the correct safe working loads. The SWL of the union rig (1.6 tonnes) should not be exceeded. The cargo runner should be seen to be in good condition and the angle between the runners should not exceed the safe working angle of 90° for normal working.
7. **Qu.** When officer of the watch, you see a man fall overboard from the fo'c'sle head area. List what actions you would expect to take.
- Ans.**
1. Helm alteration to keep the propeller clear of the man in the water, preparatory to starting Williamson turn.
 2. Main engines on standby, for immediate manoeuvre.
 3. Release the bridge wing lifebelt/smoke float.
 4. Sound general alarm/emergency boat stations.
 5. Advise the Master of the situation.
 6. Post lookouts.
 7. Hoist 'O' flag during daylight hours.
 8. Advise coast radio stations and other shipping in the area by VHF.
 9. Communications officer to stand by.
 10. Emergency boat to be made ready to launch.
 11. Hospital prepared to treat for shock and hypothermia.
 12. Continue manoeuvre to effect recovery or commence sector search.
8. **Qu.** As chief officer of a vessel, how would you instruct the bosun to renew a damaged cargo runner quickly during cargo operations?
- Ans.** Turn off all the damaged runner from the winch barrel and secure a rope messenger to the Flemish eye of the runner. Draw all the cargo runner off the derrick, pulling the rope messenger behind from the direction of the cargo hook end. Detach the old runner once clear of the derrick and secure the Flemish eye of a new runner to the messenger. Pull back on the messenger, bringing the new runner down the length of the derrick. Reconnect the eye to the barrel of the winch and run on the desired amount. Resume the rig for working cargo.
9. **Qu.** Where would you normally keep certificates of wires, blocks, shackles, chains etc.?

- Ans.** Register of ships Lifting Appliances & Cargo Handling Gear.
10. **Qu.** When lifting a 9-tonne load with a 10-tonne SWL derrick, what additional factors would you take into consideration with regard to possible overloading of the rig?
- Ans.** The weight of slings, shackles and securing arrangements must be considered within the total load.
11. **Qu.** Explain the arrangement of a Mediterranean moor and state its principal advantages?
- Ans.** The vessel is moored 'stern to the quay', being secured by both anchors forward in an open moor situation. The aft end of the vessel is secured by two stern lines and two crossed springs from each quarter. The advantage of this moor is that more than one vessel can secure to limited quay space. Also, when discharging/loading cargo from barges, both sides of the vessel can be worked at the same time.
12. **Qu.** When about to bring the vessel to a single anchor, what factors would you check and investigate before letting go the anchor?
- Ans.** Careful investigation of the charted area to obtain depth of water, type of holding ground and tidal effects, and the options for good, well spaced anchor bearing points. Obtain a current and long-range weather forecast and consider a sheltered anchorage position, preferably in the lee of the land away from prevailing winds. The anchorage should not be so close to the land as to pose a threat of a lee shore in the event of wind change. Prepare an anchor approach plan beforehand.
13. **Qu.** How would a new danger be marked in accordance with the IALA system of buoyage?
- Ans.** A new danger would be marked by one or more cardinal or lateral marks in accordance with the rules of the system. If the danger is an especially grave one, then at least one of the marks will be duplicated as soon as is practical by an identical mark. The duplicate mark will remain in position until the danger has been sufficiently publicised. The duplicate mark may carry a Racon, coded morse 'D' (— · ·) showing a signal length of 1 nautical mile on a radar display. The buoys would have quick or very quick flashing lights.
14. **Qu.** Describe the preferred channel mark to starboard as employed by the IALA system of maritime buoyage (System 'A').
- Ans.** Red can, pillar or spar buoy having a single broad green band round its centre. The spar or pillar buoys may carry a red can topmark. The light shown would be the composite group flash (2 + 1) red.
15. **Qu.** For what areas of navigation would you expect to find and employ a chart in gnomonic projection?
- Ans.** Used for polar navigation in the high latitudes, and when

- laying off great circle sailings before starting a voyage. It is not unusual to find the plan of a port or harbour printed on a mercator chart set in the gnomonic projection.
16. **Qu.** A vessel seen ahead is apparently engaged in fishing. In addition to its normal fishing lights, it shows two flashing yellow lights in a vertical line. What do these yellow lights mean to you?
- Ans.** That the fishing vessel is engaged in purse seine net fishing.
17. **Qu.** What is a safe speed?
- Ans.** A safe speed must be that at which a vessel can take proper and effective action to avoid collision and stop within a distance appropriate to the prevailing circumstances and conditions.
18. **Qu.** A power-driven vessel stops on the water at night. What navigation lights will she switch off?
- Ans.** None. The vessel is showing no special signals and is doing nothing untoward. Should there be the possibility of a collision, she could always restart her engines and commence making way.
19. **Qu.** What fog signal would a pilot vessel make when engaged on pilotage duty?
- Ans.** When under way and making way, one prolonged blast at intervals of not more than 2 minutes. When under way but stopped, two prolonged blasts in succession at intervals of not more than 2 minutes. When at anchor, rapid ringing of the bell for about 5 seconds at intervals of not more than 1 minute. (If she was over 100 m in length, then this would be accompanied by the gong signal.) In addition, she may sound an identity signal of four short blasts.
20. **Qu.** What are the obligations of the 'stand on' vessel as directed by the rules?
- Ans.** To stand on and maintain her course and speed. When from any cause the stand on vessel finds herself so close that collision cannot be avoided by the action of the give-way vessel alone, she also shall take such action as will best aid to avoid collision.
21. **Qu.** What additional day signals are fishing vessels allowed to exhibit to indicate the following:
- Hauling nets.
 - Shooting nets.
 - Nets have become fast on an obstruction.
- Ans.** (a) 'G' flag (for grabbing nets)
 (b) 'Z' flag (for zooming nets)
 (c) 'P' flag (for pinned nets)
22. **Qu.** A vessel exhibits normal steaming lights together with a flashing 'amber' light. What type of vessel could this be?
- Ans.** A submarine or a hovercraft.
23. **Qu.** If your vessel was to be taken under tow, what lights would you show at night?

Ans. Sidelights and stern light.

24. **Qu.** When on passage up a river a small craft is showing a rigid replica of the 'A' international code flag. What does this signal mean and what action would you take as OOW?

Ans. Code flag 'A' signifies, 'I have a diver down, keep well clear at slow speed'. As OOW, you should give a wide berth to the craft, and reduce your own vessel's speed on approaching and passing the area.

25. **Qu.** You are navigating with extreme caution in thick fog aboard a power-driven vessel. An order is given to 'stop engines'. At what time will you change your vessel's fog signal from one prolonged blast to two prolonged blasts, at intervals of not more than 2 minutes?

Ans. When the vessel stops making way through the water.

CERTIFICATE OF COMPETENCY FOR MASTER MARINER, CLASS 1

1. **Qu.** You are called to the bridge in your capacity as Master of the vessel. The junior officer of the watch reports that red parachute flares have been sighted four points off the port bow. What action will you take?

Ans. Assess the situation by questioning other lookouts to corroborate the officer's sighting. Check with the officer the vessel's own position and estimate the position of the flares, putting both estimated positions on the chart. Report the sighting of flares to the nearest radio station and obtain reports from that station on craft reported mission. Double lookouts and alter course to investigate the sighting on the basis that red parachute flares are a recognised distress signal. Note the time of alteration of the vessel's course, and enter the alteration into the log book. The deviation is logged for the purpose of the charter party.

2. **Qu.** The officer of the watch reports that he has just sighted a submarine sunk buoy passing down the port side. What action will you take as Master of the vessel?

Ans. Assume command of the bridge and order 'stand by engines'. Start to circle the buoy and obtain the position of own vessel. Establish by a succession of bearings and distance whether the buoy is adrift or attached to a submarine. Investigate the charted depth of water and report the findings to the coastal radio station for relay to Ministry of Defence, Admiralty (in the case of Royal Navy submarines).

Continue to circle the area, keeping the main engines turning at slow speed. Switch on echo-sounder and have a man hammer at the turn of the bilge. This should indicate to the submarine that the buoy has been sighted and a vessel is at the surface.

Clear away the emergency boat in case persons try to

escape from the submerged craft. (In less than 15 fathoms of water this escape practice is a distinct possibility.)

Provide the shore authorities with an updated report as soon as practical. Should daylight be closing, rig and check searchlights and delegate operators for these, in addition to lookout personnel.

3. **Qu.** On passage from the United Kingdom to Canada your vessel encounters dangerous ice concentrations. What are your obligatory duties as Master of the vessel?

Ans. To proceed at a moderate speed at night or to alter course to pass well clear of the danger zone. Make out an ice report to be passed via the coast radio station to the ice patrol. The report should contain the following information: type of ice, position of the ice, GMT and date of observation.

4. **Qu.** When recovering your anchor, you realise that you have inadvertently fouled a submarine cable. What action would you take?

Ans. Make every effort to clear the anchor from the fouled cable without causing damage to the cable. Should this course of action fail, slip the anchor cable and abandon the anchor. If forced to slip, buoy the end of the cable to facilitate recovery at a later time. Advise the authorities of the incident and position of the foul. Enter a statement in the log book, advise the owners of the vessel, and take steps to obtain a second (spare) anchor and cable to return the vessel to a seaworthy state.

5. **Qu.** If your vessel is in collision with another vessel, what are your statutory duties as Master?

Ans. It is the duty of every Master or person in charge of any vessel in collision to:

Render to the other vessel, her Master, crew and passengers (if any) such assistance as may be practicable or necessary to save them from any danger caused by the collision, and to stay by the other vessel until it has been ascertained that she has no need of further assistance. Furthermore the Master must give the Master or person in charge of the other vessel the name of his own vessel, the port to which she belongs, and the ports, from which she is sailing and to which she is bound.

6. **Qu.** When in command of a twin-screw vessel you suffer a complete breakdown of the steering gear, what action would you expect to take?

Ans. Depending on the position of the vessel it may be prudent to stop and take all way off the vessel, or even come to an emergency anchorage if the depth of water allows. Failing either of these options, adjustment of engine revolutions will permit reasonable steering for a limited time, depending on available sea room. Whatever option is taken, the vessel

Legal addition: The Master or Officer in charge must also report a collision to the Marine Accident Investigation Branch (MAIB) and cause an entry to be made into the official log book.

should be considered not under command and the respective day signal and/or lights displayed. Start emergency repairs as soon as possible.

7. **Qu.** On assuming command of a new passenger/ferry type vessel, explain how you would instruct your officers to disembark 600 passengers in an orderly manner, so as to avoid panic?
- Ans.** Officers would be informed of the 'muster points' for all passengers, and that these assembly points would be the public rooms, i.e. lounges, dining area etc. Passengers should then be despatched towards the embarkation deck to be loaded into survival craft, from the assembly points. Small groups of 20 or 25 should leave the assembly points to avoid panic in the lifeboat or raft areas. This number of persons can also be reasonably controlled, and a roll call can be more accurately obtained at the point of disembarkation. Most survival craft will accommodate 20 persons or multiples of 20, e.g. 4 × 15 man rafts, large lifeboats 60 person capacity, davit-launched rafts 20 and 25 man sizes.
8. **Qu.** When aboard a vessel at sea about to receive a transfer from a helicopter, state any instructions you would issue to ships' officers to ensure a safe operation?
- Ans.** Brief all operational personnel before the operation takes place, paying particular attention to the following points:
1. Ensure that all rigging and obstructions about the helicopter landing/transfer area are cleared away.
 2. Secure or stow away any loose items which may become caught with the down draught from helicopter rotor blades.
 3. Check communications with the deck controlling officer and check liaison between the bridge and helicopter.
 4. Muster damage control/fire parties close enough to the area of operations as to be available in an emergency.
 5. See static hook handler is properly equipped.
 6. Display a windsock or smoke signal.
 7. Observe helicopter operations procedure.
 8. If operating at night, provide adequate lighting without blinding the helicopter pilot.
9. **Qu.** Describe the AMVER organisation?
- Ans.** The name AMVER stands for the Automated Mutual Assistance Vessel Rescue System. It is operated by the United States Coastguard to provide aid in the co-ordination of a search and rescue operation, or other similar emergency. Vessels are encouraged to participate in position reporting in order to offer or receive aid when required. Efficient communications and the combined capabilities of many vessels can provide speedy assistance in time of need.
10. **Qu.** After a lengthy structural refit in drydock, during which

considerable alterations have been made to the vessel, what, if any, actions would you insist on with regard to the ship's compasses?

Ans. Arrangements should be made for the vessel to be 'swung' after leaving the drydock and in clear water away from any magnetic anomaly, before the next voyage begins. It would be prudent, anyway, to have the compasses taken ashore to a nautical optician during the refit.

11. **Qu.** A small fishing boat with five men on board is seen to be in distress. You are informed as Master that this small vessel is sinking and you are therefore obliged to make a rescue attempt. The prevailing weather conditions are very rough sea, wind Force 8. What options do you have in attempting to rescue the fishermen?

Ans. With the weather conditions being so bad, it would probably be impracticable to lower one of the ship's lifeboats without considerable risk to the boat's crew. The remaining options are the following:

- (a) Employ one of the life rafts belonging to the fishing vessel as a means of transporting the survivors from one vessel to the other, contact being made by rocket line.
- (b) Employ one of the rescue vessel's life rafts in a similar manner as already stated.
- (c) Go alongside the fishing vessel if circumstances permit. This option would depend on the difference between freeboards of the two vessels. In addition, the constructional features of the rescuing vessel might make the approach to the sinking craft so difficult, that a bow or stern rescue would be more appropriate, especially, say in the case of a RoRo, vessel. Scrambling nets overside may be useful.

12. **Qu.** You are 'hove to' head into the sea. Discuss how you would turn the vessel in this heavy weather, in an attempt to run before it.

Ans. In general a ship's turning circle is smaller when carried out at slow speed. The turn, therefore, should not be made at full speed, but at a slow speed, with 'bursts' on the ship's main engines to cause the propeller to bite and produce greater rudder effect. The turn should be executed in such a manner that the vessel is beam on to the weather only during relatively calm periods between waves. Waves tend to travel with variable frequency, so that such calm periods do occur. It is by careful observation of the sea state that these calm periods can be estimated and the turn successfully completed.

13. **Qu.** CO₂ gas has been injected from a bottle bank to extinguish an engine room fire. What are your actions as Master of the vessel, if you think the fire is out?

Ans. Providing that there are no other adverse conditions, e.g. 'bad weather', to complicate the situation, it would be advisable to wait before carrying out any inspection. This waiting period could be usefully employed by maintaining 'boundary cooling' and observing the temperatures of the steel work at various levels around the engine room casing. Once a distinct fall has been observed in temperatures, an internal inspection and assessment may be ordered.

Breathing apparatus should be worn by two persons, one acting as back-up to the inspecting officer, who should be a responsible engineer who would know the engine room layout and be able to make a comprehensive report (probably the second engineer). The inspection personnel should be equipped with spray fire fighting equipment.

Once the inspection report has been made, a further delay may prove a prudent move in order to allow hot metal to cool down further. At no time should oxygen have access to the engine room area. An additional assessment should now be made by internal inspection, probably by the chief engineer. This would not only provide a more experienced assessment but a worthwhile second opinion.

Should both opinions agree that the fire is out, a further delay would be considered before a damage control party entered the engine room for cooling down work. When all metal components have cooled, ventilation may be started.

14. **Qu.** After a collision with another vessel, in which your own ship suffers considerable damage, you decide to beach the vessel to avoid sinking. Discuss your actions before and on taking the beach.

Ans. Once the decision to beach has been made, the aim is to land in a manner to reduce further damage, with the view to refloating at a later stage. A gentle sloping, sandy beach would be the ideal place.

The approach would normally be made in the 'end on' position, if at all possible. This would tend to restrict additional damage to the forefoot and the bottom plates, while favouring the bilge areas. The damage might be contained by the collision bulkhead and the tank tops of the double bottom.

If circumstances permit, one or both anchors should be let go and paid out as the approach to the beach is made. Care should be taken that the anchors are let go clear of the position at which the vessel intends to come to rest. A real danger of letting go anchors when in the process of beaching is that the vessel may come to rest sitting on top of them, causing severe damage to the double bottom structure. The advantage of having anchors out off the stern quarter(s) is that considerable weight can be put on to the cables when attempting to heave the vessel back afloat.

There is advantage in approaching the beach at a slight angle. The port anchor is let go and the ship turned to port to take the beach end on. This will keep the anchor clear of the bottom and help keep the vessel straight when coming off with engines going astern.

Before taking the beach, if time permits, the ship's ballast tanks should be filled. This will not only assist the vessel when the time comes to refloat, by allowing the trim of the craft to be changed, but also it will add strength to the fore end at the time of taking the ground. Moreover, with full ballast, should the weather turn for the worst, then the additional weight of ballast would help prevent the vessel from bumping and working herself further up the beach and damaging the bottom plates.

Once the vessel has landed, it is necessary to make a complete sound round all the vessel's tanks, together with a complete sound round the vessel's hull to find out the depth of water, specifically around the ship's propeller. The engines should be stopped immediately on taking the ground. Should this not happen, the soundings may show build-up of a mud or sand bank directly astern, which may hamper the operation of refloating.

Make a full assessment of damage to the ship and instigate emergency repairs as soon as possible. Note any casualties and return a comprehensive damage report to owners and relevant authorities. See that an entry is made in the ship's log book as soon as practical after the event.

Check the vessel's position, and seek information on the next high tides and on the state of the tide when striking the beach. Examine leaking compartments, plug or patch as required and pump dry any flooded areas. Obtain updated weather reports as soon as possible after the event.

15. **Qu.** You are aboard an ice-strengthened vessel and navigating in 'close pack ice'. Discuss in general terms your actions as Master and your navigational progress.

Ans. It is generally accepted that any vessel navigating in ice should endeavour to keep moving, no matter how slowly. Once a vessel becomes trapped in ice, then she goes wherever the ice moves, not where the Master wishes.

Progress will depend on successfully following leads in the pack ice field. The vessel's speed should be considerably reduced for any form of ice navigation, especially when in close pack ice. Should the vessel be stopped by the sheer weight of ice ahead, main engines should be put astern to allow her limited freedom of movement. The action of going astern may also cause ice movement in the way of cracks and new leads. When re-entering ice after a stern movement, the vessel should proceed slowly then increase speed in order to maintain headway.

Double lookouts should be employed throughout ice navigation, with searchlights being used during the hours of darkness. The position of the vessel should be kept under regular observation and good communications with shore radio stations maintained.

Probably the most vulnerable parts of any vessel navigating in heavy ice concentrations are the propellers, especially when the vessel is moving astern, and great care should then be observed. At no time should the vessel attempt to break through glacial ice. This type of ice formation is usually very large and extremely solid and should be given a wide berth.

Should the vessel become 'stuck' in ice, then limited alternatives are open: (a) go astern, (b) put rudder midships and leave engines running ahead to clear ice floes astern, or (c) transfer ballast and change trim to bring about the vessel's release. Masters should avoid using anchors, if at all possible. Should the ice be moving, there would be a distinct possibility of breaking the anchor cable for the cable and the ship's bow might act to trap large moving ice floes.

It is dangerous to follow close inshore leads, especially when an onshore wind is blowing. Ice convoys and the assistance of ice-breaker patrol ships are the obvious and safest guarantees of transit, but these specialised ice strengthened vessels may not always be present when they are needed.

16. **Qu.** When siting the position of the ship's whistle in accordance with Annex III of the rules, state why it should be positioned as high as practicable, and if more than one whistle is fitted, state when they would not be sounded simultaneously.

Ans. Whistles should be positioned as high as practicable so as to transmit their signal as clearly as possible without interference from obstructions. If more than one whistle is fitted and the distance between them is more than 100 m, they should not be sounded simultaneously.

17. **Qu.** You are navigating in a narrow channel when a vessel astern sounds two prolonged blasts, followed by one short blast on the whistle. What do you understand from this signal and what action would you expect to make on your own vessel if you are in agreement with the purpose behind the signal?

Ans. The whistle signal indicates 'I intend to overtake you on your starboard side' (Rule 34(c)). If the vessel to be overtaken is in full agreement with the proposed action, a return signal of one prolonged, one short, one prolonged and one short blast, should be made by the vessel to be overtaken, which should then take the necessary action to allow overtaking.

18. **Qu.** When navigating in a traffic separation scheme, a junior watch officer calls you to the bridge in your capacity as Master of the vessel. A crossing situation with another vessel is apparent. The crossing vessel is positioned 4 points off the port bow at an approximate range of 3.5 miles. State what would be your probable action in the circumstances and justify your answer.

Ans. I would assess the situation with regard to such navigation hazards as other traffic or shallow water, and check the systematic plot on the radar against the visual aspect of the crossing vessel. Observing the collision regulations in respect of the fact that mine was the stand on vessel, I would maintain my course and speed.

Should the situation continue to develop, I would expect to take the following action: sound five or more short and rapid blasts on the ship's whistle to indicate doubt as to the intentions of the crossing vessel. If no corrective action was immediately taken by that vessel in response to this signal, then I would instigate the following actions so as to avoid collision: sound one short blast on my ship's whistle and make a broad alteration of course to starboard, or take all way off my own vessel immediately. In no way would the presence of the separation scheme alter my action.

19. **Qu.** On a vessel at anchor, in restricted visibility, what additional sound signal may be made before or after the normal fog signal in order to give warning of the vessel's position? May this signal be used in clear visibility? If it is not to be used, explain why not.

Ans. A vessel at anchor may in addition to the normal fog signal sound three blasts in succession, namely one short, one prolonged, and one short blast, in order to indicate her position. This signal is prescribed by the rules under the heading for sound signals in restricted visibility only. Therefore, it would not be sounded in clear visibility.

20. **Qu.** When navigating in a narrow channel, with shallows and exposed banks either side, a large dry cargo vessel is confronted with a small speedboat (less than 20 m in length) and a person on water skis. Directly in front of the vessel, the person loses his balance and falls from the skis. The cargo vessel is approximately $\frac{1}{4}$ mile from the man in the water. What action would you take as Master of the cargo vessel? By what authority are you taking this action?

Ans. As Master of the vessel, I would order main engines stopped and try to reduce way, possibly by going full astern. If there was room to manoeuvre inside the channel around the man in the water, then I would do so. Should this not be possible, I would order double full astern (crash full astern). Depending on the circumstances, I would try not to ground

the vessel. Regulation 9(b) – A vessel of less than 20 m in length shall not impede the passage of a vessel which can safely navigate only within a narrow channel or fairway.

21. **Qu.** Your vessel is approaching a vessel displaying lights which indicate she is engaged in fishing, when a searchlight is suddenly switched on and directed towards a point approximately $\frac{1}{2}$ mile ahead of you. What would you understand from this action and what would you instruct the officer of the watch to do?

Ans. Under Rule 36 of the regulations, I would assume that the vessel engaged in fishing was trying to attract my attention by directing a searchlight in the direction of the danger. I would require a full assessment of the situation and would stop my own vessel, take all way off and order the OOW to obtain a current position on the chart. I would compare the position with other charted navigation hazards, if any, and take action to avoid the area. I would communicate with the fishing vessel by VHF or Aldis lamp to establish the type of danger, and take action in accordance with the information received from the fishing vessel.

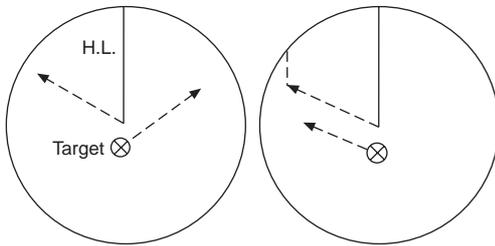
22. **Qu.** When navigating in clear weather, you see that your course will cause you to enter a fogbank right ahead. You instruct the officer of the watch to switch on the radar, tune the set in, and start making a fog signal. On entering the fogbank at a reduced speed, the OOW reports that the radar is tuned in and operational and that there is a target vessel 2 miles dead ahead on the heading line marker, radar being in the ship's head up presentation. What would be your probable intended action? Justify this action.

Ans. I would stop my vessel and take all way off, to avoid collision with the target vessel. Under the regulations, Rule 8, stopping and taking all way off would give me more time to carry out a systematic plot of the target and to make a full assessment of the situation. I would not take any immediate action other than that stated. Under Rule 7(c), assumptions should not be made on scanty information, especially scanty radar information.

23. **Qu.** When navigating in a narrow channel and rounding a 'blind' bend, you hear a sound signal of one prolonged blast, followed by two short blasts, at intervals of not more than two minutes. What action would you take aboard your own vessel?

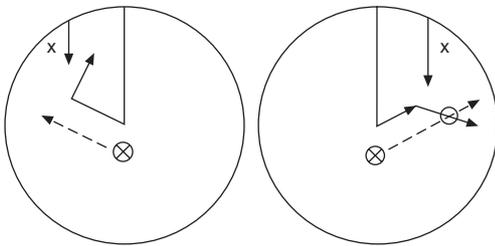
Ans. Order an immediate reduction of the ship's speed and prepare to enter poor visibility. The sound signal around the bend is a fog signal of a hampered vessel. I would navigate with extreme caution until all risk of collision is over.

24. **Qu.** You are navigating in thick fog, when a target vessel is plotted on radar. You are Master of the vessel and in command



PPI Display 1.
Recommended action, on the assumption that the target will alter to starboard.

PPI Display 2.
Action if the target takes the alternative action of altering course to port.



PPI Display 3.
By an alteration to port for the original target, you are able to alter to starboard for vessel 'X' and remain within the correct procedure of the regulations.

PPI Display 4.
If you had made an alteration to starboard, then by not being allowed to alter course to port for vessel 'X' an alteration to starboard would have resulted in another close quarters situation with the original target vessel.

of the bridge. The target vessel is reported by the OOW as being 4 miles dead astern, and its range is closing. Explain your probable action and justify this action.

Ans. In accordance with the instructions of Rule 19 of the regulations I would probably make a bold alteration of course to port. This action would be taken on the assumption that the target vessel would alter to starboard, if she is going to alter at all. The reasoning behind this is that to the other vessel I would appear forward of his beam.

However, Rule 19 recommends that the following should be avoided: 'an alteration of course to port for a vessel forward of the beam, other than for a vessel being overtaken'. If the situation is considered, it will be seen that the target vessel is overtaking, and therefore will have the option of an alteration of course to port or starboard (see opposite).

A bold alteration to port would provide definite information to the target vessel, if radar is being observed. This alteration would clearly take into account any shadow sectors being carried by the target vessel's radar position.

The reasoning behind the probable alterations of both your own vessel to port and the alteration of the target to starboard are illustrated opposite. Assume an additional target 'X' is on a reciprocal course (see opposite).

In all situations, any action taken will depend on full consideration of all the circumstances at the time. The answer provided in this question must be read with the weather and traffic conditions at the time in mind. A probable line of action is suggested, but there are alternatives.

25. **Qu.** What lights and fog signal would be exhibited by a pilot vessel on station when at anchor?

Ans. The vessel would show anchor lights, as for a vessel of her length, and white and red, all round lights, vertically displaced one over the other. The fog signal would be as for any other vessel of her length, but, in addition, she may sound an identity signal of four short blasts.

26. **Qu.** The employer must appoint a Safety officer, and it is the Master's duty as the employer's representative to ensure this is done, if the ship carries more than five (5) crew. Can the Safety Officer resign?

Ans. No. Unlike a safety representative who is elected by the crew. Safety representatives can be replaced by the crew electing another person to replace him.

27. **Qu.** Can the Safety Officer stop work being carried out on board?

Ans. Yes. The Safety Officer has the authority to stop any work being carried out which he considers may be unsafe or lead to unsafe practice.

28. **Qu.** What are the duties of the Safety Officer?

Ans. The Safety Officer would investigate any and all accidents on board the vessel. He would also obtain statements from witnesses to the accident and report his findings to the Safety Committee and complete the accident reports. He would also make recommendations on safe working practice and safety policy effecting the ship. He would also carry out regular Safety Inspections of all accessible areas of the vessel.

28. **Qu.** Where would you obtain details of the safety requirements regarding Safety Officers, Safety Committees, and safety policy affecting the ship?

Ans. Code of Safe Working Practice for Merchant Seamen.
Merchant Shipping Notices (MSNs)
Guidance Notes for Safety Officials (1982 S.I. 876)

30. **Qu.** What entries are required in the Official Log Book, regarding the ship's safety officials.

Ans. The Master must record all Safety appointments in the Official Log Book.

INDEX TO PART ONE



- 'A' Frame, 6
- Abandon ship, 222
- Abandon ship drill, 242
- Abeam, 1, 2
- Ahead, 2
- Alarm signals, 240
- Alternative tonnage mark, 23
- Amidships, 2
- Anchor and cable certificates, 29, 30
- Anchor and cable construction, 26–31
- Anchors and cable work, 25
- Anchor cable securement and fittings, 30–35
 - bitter end, 34, 41
 - bow stopper, 33, 37
 - cable holder, 38
 - cable joining shackles, 30–33, 40
 - 'D' Lugged, 32, 33
 - Kentor Lugless, 30, 31
 - cable locker, 33, 34
 - chain reliever, 38
 - compressor, 33, 35
 - devils claw, 33, 38
 - guillotine, 35
 - gypsy, 33, 36
 - hawse pipe, 33, 34
 - lashings, 37–41
 - scotsman, 38
 - snug, 35, 38
 - spurling pipe (naval pipe), 33, 35, 45
 - swivel, 33
 - windlass and capstans, 35–37
- Anchor moorings, 57, 58
 - Bruce, 57
 - improved mooring, 58
 - Trotman anchor, 58
- Anchor operations
 - approach plan, 38, 39
 - bell signals, 40
 - clearing foul hawse, 43, 50–52
 - deep water anchoring, 49
 - hanging off anchor, 54, 55
 - laying or carrying out anchors, 49, 50
 - marking cable, 40
 - recovery, 52, 53
 - re-securing spare anchor, 55–57
 - single anchor procedure, 39
- Anchor parts, 25–27
 - anchor crown 'D' shackle, 33
 - arms, 25, 26
 - crown, 25, 26
 - flukes, 25, 26
 - forelock, 25
 - gravity band, 25
 - head...of anchor, 26
 - pea or bill, 25
 - shank, 25, 26
 - stock, 25, 26
 - tripping palms
- Anchor terminology, 41–46
 - anchor 'a' cock a bill, 41
 - anchor aweigh, 41
 - anchor buoy, 41
 - anchor coming home, 42
 - anchor dragging, 42
 - anchor warp, 42
 - brought up, 42
 - cable clench, 42
 - cable length, 42
 - cat an anchor, 42
 - drop an anchor under foot, 42
 - foul anchor, 43
 - foul hawse, 43
 - cross, elbow, round turn, 43
 - ganger length, 54
 - grow, 43
 - gypsy, 43
 - hawse pipe, 34, 43
 - hove in sight, 43
 - joggle shackle, 44
 - kedging, 44
 - long stay, 44
 - ream out a shackle, 44
 - render cable, 44
 - scope, 44
 - shackle of cable, 44
 - sheer, 44
 - sheet anchor, 45
 - shorten cable, 45
 - short stay, 45
 - snub, 45
 - spurling pipe, 45
 - surge, 45
 - tiderode, 45
 - up and down, 45
 - veer cable, 45
 - walk back, 45
 - windlass brake, 34, 35
 - yaw, 46
- Anchor tests, 27, 29
 - bending test, 29
 - drop test, 27
 - percussion test, 27
 - proof loads, 28
- Anchor types, 25
 - Admiralty cast, 25
 - Admiralty pattern, 25
 - CQR, 26, 27
 - Danforth, 26, 27
 - Fishermans anchor, 25
 - Stockless anchor, 26
- Anchor watch, 46
 - dragging anchor, 46, 47
 - duty of OOW, 46, 47
 - transit bearings, 47
- Anchor work accessories, 38
 - cable jack, chain hook, drifts, 38

- Angle bar, 20
 Answering pennant, 252, 253
 Apron, 168
 Awning screw, 89
- Bagged cargo, 155
 Bailer, 174
 Bale sling strop, 72, 156, 157
 Bale space, 152
 Ballast, 21
 Ballast tank, 7
 Band brake, 35
 Barrel sling, single, double, 72
 Barrel stowage, 155
 Beaching, 198, 199
 - lifeboat, 198
 - liferaft, 227
- Beam, 2, 4
 Beam knees, 19
 Beams, 19
 Bends and hitches, 67–81
 - blackwall hitch, 67
 - bowline, 67, 68
 - running bowline, 67, 68
 - bowline on the bight, 67, 68
 - catspaw, 69
 - clove hitch, 69
 - cow hitch, 69
 - diamond carrick bend, 69
 - double blackwall hitch, 67
 - double carrick bend, 69
 - double sheet bend, 71
 - figure '8' knot, 69, 70
 - fishermans bend, 70
 - french bowline, 68
 - marline spike hitch, 69, 70
 - midshipmans hitch, 70
 - reef knot, 70, 71
 - rolling hitch, 70
 - round turn and two half hitches, 70, 71
 - sheep shank, 71
 - sheet bend, 71
 - single carrick bend, 68, 69
 - timber hitch, 70, 71
- Bilge pumping arrangement, 7
 Bilge suction, 145, 146
 Bilge turn of, 145
 Binding, 98, 99
 Bits, 35, 67
 Blake slip, 91, 92
 Block coefficient, 4, 5
 Block internal fitments, 99
 Block parts of, 98, 99
 - arse, 98
 - binding, 99
 - bush, 99
 - cheeks/plates, 99
 - cross head, 99, 100
 - crown head, 98
 - distance piece, 99
 - inspection plate, 98
 - pin (bolt), 98, 99
 - rope guards, 99
 - sheave, 98, 99
 - swallow, 98
 - swivel hook/becket, 98–100
- Block inspection, 98, 99
 - lubrication, 98
 - protection, 98
 - order new, 98
- Block maintenance, 96
 Blocks and tackles, 100–105
 Block types, 98
 - chain blocks, 103–105
 - external bound, 99
 - gin, 99
 - head block, 100
 - heel block, 100
 - internal bound, 99
 - metal block, 99
 - snatch block, 99
 - wood block, 98
- Blue ensign, 258, 259
 Boat construction, 168
 - carvel, 171
 - clinker, 171
 - double diagonal, 171, 172
 - GRP(Glass reinforced plastic), 172
- Parts of a lifeboat, 168
 - Apron, 168
 - bilge grabrail, 168, 172
 - bottom boards, 172
 - buoyancy chambers, 168, 172
 - deadwood, 168
 - filling piece, 168
 - gangboard, 168
 - garboard strake, 168
 - gunwale, 168, 169, 172
 - gunwale capping, 168
 - hardwood chock, 168
 - hog piece, 168
 - keel, 168, 172
 - keelson, 168
 - lifting hooks, 168, 172
 - mast thwart, 188
 - painter shackle, 168
 - rising, 168
 - rubbing strake, 168, 172
 - scarph, 168
 - sheer strake, 168
 - side bench, 168, 172
 - sling plate, 168
 - stem post, 168
 - stem band, 168
 - stern band, 168
 - stern post, 168
 - stretcher, 172
 - tank cleading, 168, 172
 - thwart, 168, 172
 - thwart knees, 168, 172
 - timber (ribs), 168
- Boat equipment, 172, 174–177
 - axes, 174
 - bailer, 174
 - boat hooks, 174, 176
 - buckets, 174
 - compass, 175
 - crutches, 172
 - dippers, 176
 - drinking vessels, 176
 - engine tools, 175
 - exposure cover, 175
 - fire extinguisher, 175
 - first aid outfit, 176, 211
 - fishing tackle, 176
 - heliograph (daylight signal mirror), 174, 209
 - jack knife, 174
 - manual pump, 174
 - oars, 174
 - oil bag, 175
 - painters, 175, 188
 - pyrotechnics, 174
 - radar reflector, 175
 - rations, 176
 - rescue coit, 174
 - rescue signal table, 175, 177
 - sea anchor, 174, 175
 - search light, 176
 - steering oar, 174
 - survival manual, 174
 - thermal protective aids, 176
 - torch, 174
 - water container, 173, 176
 - whistle, 174
- Boat fitments, 172, 186
 - automatic bailing, 187

- Boat fitments (*Contd*)
 drain valves, 186
 lamp, 187
 lifeboat engine, 178, 179
 mast and sails, 188
 rowlocks, 172
 rudder and tiller, 187
 skates, 173
 thole pins, 173
 watertight lockers, 173
- Boat launching procedures, 183, 191–195
 boat operations, 196
 beaching, 198, 199
 boat handling, 200
 boat recovery, 197, 198
 goose winging, 202, 203
 gybing, 202
 heaving to, 175
 reefing, 202, 203
 running, 202
 sail terms, 6, 203
 sail theory, 201–203
 tacking, 201
 wearing, 201, 202
- Boat rigging, 188
 buoyant lifeline, 189
 bowing tackles, 190
 gripes, 191
 keel grab lines, 189
 lifeboat falls, 86, 88, 189, 190
 lifelines, 189
 mast and sail rig, 188
 painters, 188, 189
 tricing pennants, 190, 191
- Boatwork, 166
 access into lifeboats, 167
 lifeboat buoyancy, 167
 lifeboat construction, 166, 168
 lifeboat markings, 168
- Bolster, 34
 Booby hatch, 144
 Boom, 106
 Boss plate, 6
 Bosuns chair rigging, 71, 73
 Bottle screws, 89, 90
 Boulevart eye splice, 93–96
 Bow stopper, 33, 35, 37
 Bow visor, 163
 Breadth, 3
 Breaking stress
 (cordage, wire, and chain), 83
 Broken stowage, 152
 Bruce anchor, 57, 58
- Bulb angle/plate, 20
 Bulk cargoes, 146, 155
 coal, 155
 edible oil, 155
 scrap metal, 150
 deep tank stowage, 146
- Bulk carrier, 12
 Bulkhead, 19
 collision, 4, 6
 Bulldog (rope) grip, 90
 Bulwark, 17
 Bull wire, 107, 146
 Butterfly rig, 113, 114
- Cable, 29, 33
 clench, 38, 42
 drum, 33, 38
 holder, 35, 38
 jack, 38, 42
 laid rope, 62
 locker, 33, 34
 locker lashing, 41
- Camber, 2, 3
 Cantons, upper and lower, 257
 Capstan, 37
 Cargo handling procedure, 156
 can hooks, 159
 nets, 157
 plans, 164
 plate clamps, 157, 158
 runner, 107, 108, 110, 113
 slings, 157, 158, 159
 snotters, 156
 timber dogs, 157, 158
 vessel, 7, 17
 working, 153–165
- Carrick bend, 68, 69
 Carvel, 171
 Catspaw, 69
 Ceiling, 17, 145
 Cellular double bottom, 7, 145
 Centre of buoyancy, 5
 Centre of floatation, 5
 Centre of gravity, 5
 Chain block, 103–105
 Chain cable, 29, 31
 hook, 38, 42
 tests, 29
 types, 30
- Chain preventor, 107
 Channel bar, 20
 Cheek plates, 99
- Cheese rope, 81
 Chemical carrier, 11
 Chinese stopper (West Country), 80
 Clear, 93
 Clew, 201
 Clinker, 171
 Close up, 203
 Close reach, 203
 Clove hitch, 69
 Coefficient of fineness, 5
 Coffin plate, 6
 Coir rope, 61
 Collision bulkhead, 4
 Common link, 33, 40
 Common whipping, 77, 78
 Communications, 245
 Compressor, 33, 35
 Conical sockets, 90
 Container tonnage, 162
 Conventional hatch, 142, 143
 Copra, 155
 Courtesy ensign, 258
 Cow hitch, 81
 Cowl ventilator, 159
 Coxwain's responsibilities, 192, 200
 CQR anchor, 25, 26
 Cranes, 121, 122
 Cross, 43
 Cross head, 90
 Cross lay, 84
 Crown, 26
 Crutches, 172
- Danforth anchor, 26, 27
 Dangers—open boats, 201
 Davit launched liferaft, 216
 Davits, 169, 185, 191, 193
 Deadweight, 6
 Deadweight cargo, 152
 Deadwood, 168
 Deck, 4
 Deck cranes, 121, 123, 124
 Deep tanks, 146
 Deep tank cargo, 160
 coconut oil, 161, 162
 tallow, 161, 162
 whale oil, 161, 162
 Deep water anchoring, 49
 Depth, 3
 Derricks, 106
 calculations, 127–141
 crutch, 108, 109

- Derricks (*Contd*)
 hallen, 115, 116
 heavy lift, 118–121
 heel block, 107, 108
 operational hand signals, 127, 128
 single swinging, 107, 108
 stulken, 121
 tests and surveys, 125
 topping lifts, 107–110
 union rig, 110–112
 velle, 116, 117
- Devils claw, 33, 38
- Dewpoint, 159
- Dip (flags), 259
- Dipping ensign, 259
- Displacement, 5
 light displacement, 5
 load displacement, 5
 tonnage, 5
- Dolly winch, 107
- Double bottom tanks, 17, 145
- Double diagonal, 171, 172
- Double luff tackle, 102
- Double up procedure, 113
- Doubler, 34
- Dovetail chamber, 31
- Dragging anchor, 47, 48
- Drain valves, 186
- Draught, 3
- Draw bolt, 218
- Drift, 31, 38
- Drills, 242, 243
- 'D' ring HRU, 218
- Drop test, 27
- Dry dock stresses, 21
- Duck bill fitment, 100
- Duct keel, 17
- Dunnage, 152
- Eccentric wheels, 148
- Edible oil, 155
- Efficient deck hand, 264
- Eight strand plaited, 62
- Elbow, 43
- Embarkation ladders, 193, 195
- Emergency alarm, 240, 241
- Emergency communications, 240
- Empirical formula, 132
- Enclosed lifeboats, 179–185
- Engine (lifeboat), 178, 179
- Engine room, 14
- Ensigns, 257
- blue, 258, 259
 red, 259
 white, 257
- EPIRB's, 246, 247
- Epoxy coating, 9
- Equal lay, 84
- Equilibrium, 5, 6
- Evacuation systems, 225–227
- Exposure cover, 175
- Extra flexible steel wire rope, 83
- Eye bolt, 91
- Eye splice (rope), 76
- Eye splice (wire), 93, 94, 95
- Fairlead, 35
- Feral, 92
- Fid, 74
- Figure '8' knot, 69, 70
- Filler, 171
- Fire protected boats, 179–182
- First aid outfit, 211
- Fishermans bend, 70
- Flag maintenance, 257, 258
- Flag recognition, 251, 252
- Flag signalling, 249–256
- Flags: courtesy, house, 258
- Flake, 81
- Flare, 3
- Flat seizing, 73, 74
- Flexible steel wire rope, 83
- Float free arrangements, 220
- Floating block, 190, 197
- Floor, 17, 19
- Flotation, 5
- Flour cargo, 156
- Fly, 199, 202
- Foot, 201
- Fore and aft line, 4
- Forestay, 86, 188
- Foul anchor, 43
- Foul hawse, 43, 50–52
- Frame, 17, 19
- Freeboard, 3
- Free fall lifeboats, 183
- Friction allowance, 130
- Fruit cargo, 156
- Gaff, 6, 259
- Gangboard, 168
- Ganger length, 33, 54
- Garboard strake, 168
- General cargo terminology, 152, 153
- General cargo vessel, 7, 17, 142, 164
- General emergency alarm, 240
- 'G' flag, 250, 251, 258
- G gravity, centre of, 5
- Girders, 19
- Glass cargo, 156
- GMDSS, 245, 246
- GM–metacentric height, 6
- Gooseneck, 107, 132
- Goosewinging, 202, 203
- Grain, 154
- Grain space, 152
- Gravity davits, 191, 192
- Grease recess, 99
- Gripe, 191
- Gripe sheave, 191
- Grommet, 175
- Gross tonnage, 5, 24
- Grow, 43
- Guillotine bar, 35
- Gun tackle, 101
- Gunwale, 168
- Gunwale capping, 168
- Gunwale chock, 168
- Gusset plate, 17
- Guy, preventor, 110, 113
- Guys–slewing, 107, 111, 112
- Gyn, 127
- Gyn tackle, 103
- Gypsy, 43
- Hallen derrick, 115, 116
- Halls stockless anchor, 26
- Halyard, 65
- Hand signals for lifting operations, 128
- Handy billy, 101
- Hanging off an anchor, 53, 54
- Hambroline/houseline, 63
- Hard eye, 76, 92
- Hard laid rope, 62
- Hardwood chock, 108
- Hat box, 146
- Hatch, 17, 142
 board, 142, 143
 chain pull, 146
 construction, 143
 conventional, 142–145
 covers, 142–156
 slabs, 142
 steel/hydraulic, 146–152
 tents, 144, 145

- Hatchway, 143
 Hawse pipe, 33, 34, 163
 Hawser lay, 60, 62
 'H' bar, 20
 Head, 99
 Head block, 100
 Heart (of wire), 85
 Heaving too, 175
 Heavy lift, 118–121
 Heel block, 107
 Heel of mast, 188
 Heel tackles, 126
 Heliograph, 209
 Hemp rope, 61
 Hitches, 67–73
 Hogging, 22
 Hog piece, 168, 171
 Hold, 17
 ceiling, 17
 construction, 17
 preparation, 154
 Home, anchor coming, 42
 Houndsband, 89, 188
 Hove in sight, 43
 Hydraulic mooring winch, 36

 Immersion suits, 233–236
 Inflatable lifejackets, 229–231
 Inflatable liferaft, 204–228
 Inflated rescue boat, 237, 238
 Inglefield clip, 257
 In irons, 203
 Inner bottom longitudinals, 17
 Insulation material, 159
 Intercostals, 17
 International code of signals, 250, 251
 International conference on loadlines, 23

 Jack, 148
 Jaw (rope), 59
 Jaw (shackle), 32
 Jib, 6, 124, 201
 Jigger, 102
 Joggled plate, 17
 Joggle shackle, 44
 Jubilee clip, 51
 Jumbo derrick, 91, 119
 Jumper stay, 89

 Kedging, 44

 Keel, 168, 171
 grabline, 189
 rake, 4
 Keelson, 168, 171
 Kenter joining shackle, 30, 31
 King beam, 143
 Knee, 17, 168

 Langs lay, 84
 Lanyard, 172
 Lashing cables, 50, 51
 Launching, 191–196
 lifeboat procedures, 191–193
 stations, 193
 rescue boats, 237–240
 Laying out anchors, 49
 Lay of rope, 59, 62, 80, 84
 Lead block, 107, 108, 120
 Leadline, 64
 Lead pellet, 31
 Leech, 201
 Length, 3
 between perpendiculars, 3
 on waterline, 3
 overall, 3
 Length of lay, 62, 84
 Letting go anchors, 34
 Lifeboat (*see also* boat construction and
 boatwork), 166
 engine, 178
 equipment, 174–177
 falls, 189, 190
 question and answer, 266–268
 Lifebuoy specifications, 231–233
 Life jacket requirements, 229
 Life jacket lights, 230
 Lifelines, 189
 Liferaft, 204–229
 capacity, 208
 construction, 204, 206, 221
 davit launched, 214–218
 equipment, 208–211
 fittings, 207, 221
 float free arrangement, 218–221
 launching of, 211, 212
 markings, 208, 211, 213
 stowage, 210, 228
 Lightening holes, 17, 18
 Limber boards, 145
 Liner, 17
 Load deadweight, 6
 Loadlines, 23, 24

 Load stresses, 20, 21, 22
 Locking bar, 144
 Locking splice, 93–95
 Logline, 64
 Longitudinal girders, 17, 20
 Longitudinals, 17, 18
 Long splice, 76, 77
 Long stay, 44
 Loss of anchor, 55–57
 Loss of windlass power, 52, 53
 Lower hold, 17
 Lowering hitch, 73
 Lowering turns, 73
 Lubrication (wires), 85
 Luff, 201, 203
 Luff tackle, 102, 103
 Lug, 32
 Lugged joining shackle, 32, 33, 40
 Lugless joining shackle, 30, 31, 40
 Lumber loadline, 24

 Macgregor steel hatches, 146–152
 Main halyard, 188
 Main mast, 6, 188
 Main sail, 6, 201
 Main staysail, 6
 Main topsail, 6
 Maintenance of
 blocks, 99
 flags, 256, 257
 lifeboats, 184
 planned, 82, 112
 Manhelper, 51
 Manilla rope, 59
 Mast truck, 254
 Marine evacuation system, 225–227
 Marking anchor cable, 40
 Marking of anchors, 29
 Marking of sails, 201
 Margin plate, 17, 145
 Marline, 63, 64
 Marline spike hitch, 69, 70
 Marry two ropes, 78
 Martingale, 126
 Mast, 6, 188
 clamp, 188
 house, 120
 main, 6
 mizzen, 6
 rigging, 188
 step, 188
 thwart, 188

- Measurement cargo, 153
 Measurement (rope and wire), 86
 Mechanical advantage, 101, 102
 Messenger, 50
 Metacentre, 5
 Metacentric height, 5, 6
 Metal blocks, 99, 100
 Midshipmans hitch, 70
 Mills atlas release, 217
 Mizzen topmast staysail, 6
 Mooring, 44
 anchors, 57, 58
 new rope, 81
 shackle, 58
 wire, 88, 97
 Morse code, 261
 Morse procedure, 260–262
 Moulded dimensions, 3
 breadth, 3
 depth, 2, 3
 Mousing hook and shackles, 97, 98
 Moving block, 101, 190, 197
 Multi-fold hatches, 151, 152
 Muster lists, 241
 Muster signals, 240, 268
- Natural fibre rope, 59
 Naval pipes, 45
 Net tonnage, 5
 Non-return valve, 145
 Numeral flags, 252
 Numerals morse, 261
 Nylon rope, 65
 Nylon strop, 197
- Oars, 174
 Offshore supply craft, 13
 Oil bag, 175
 Oil fuel tanks, 7, 15, 180
 Oil separator pump, 15
 Oily/water separator, 15
 Open boat dangers, 201
 Open hatchway, 150
 Opening hatches, 142–152
 Opening new ropes, 81
 Opening new wires, 97
 Open link, 34, 39
 Oxter plate, 18
- Pad eye, 91
 Painter, 174, 184, 192, 196
 Painter shackle, 168
 Palletisation, 156, 157
- Palm and needle whipping, 78
 Palm oil, 162
 Panting beams, 18
 Panting stringers, 18
 Parceling, 75, 76
 Partially enclosed boats, 180, 186
 Passenger car ferry, 8
 Passenger ships, 181
 Pay off, 203
 Peak, 201
 Pear link, 111
 Perpendiculars, 3
 Phonetic alphabet, 260
 Pillars, 19
 Plain laid, 63
 Plaited rope, 62
 Plan for anchoring, 38, 39
 Plate clamps and dogs, 157, 158
 Plate landings, 17, 18
 Pneumatic windlass, 36
 Point line, 64
 Polyester, 66
 Polypropylene, 66
 Pontoon covers, 150
 Performing, 85, 86
 Preparation of anchors, 34, 38, 40
 Preventor, 91
 backstay, 91
 guys, 108, 110, 111
 wire, 111
 Procedure for anchoring, 38, 39
 Product carrier, 9
 Proof load
 anchors, 28
 cable, 31
 derricks, 125
 Punch and drift, 31
 Purchase (tackle), 100
 advantage, 101, 102
 calculations, 130–141
 differential, 105
 friction allowance, 101, 130
 gun tackle, 101
 gyn tackle, 103
 handy billy, 101
 jigger, 102
 luff (single and double), 102, 103
 three fold, 103
 Pyrotechnics, 174
- ‘Q’ Flag, 250, 251
 Quarter, 2
 Queen beam, 143
- Quick link, 91
 Quoins, 155
- Rack and pinion hatches, 150
 Racking seizing, 74
 Racking stresses, 21
 Raft release gear, 218–221, 228
 Raised strakes, 17
 Rake of keel, 4
 Ramp, 163
 Rations, 210
 Ratline, 64
 Reach, 203
 Ream, 44
 Recovering anchors, 52, 53
 Recovering boats, 197, 198
 Red ensign, 259
 Reefer cargo, 158–160
 Reefer ship, 12
 Reefing sails, 202, 203
 Reef knot, 70, 71
 Refrigerants, 159
 Release gear-boats, 184, 185
 Render cable, 44
 Rescue boats, 237
 equipment, 238, 239
 requirements, 238
 Re-securing anchors, 55–57
 Reserve buoyancy, 6
 Rib (timber), 168
 Riding cable, 50, 52
 Rigging, 82
 bosuns chair, 71, 73
 derricks, 106–112
 fid, 74, 75
 fitments, 91
 gyn, 127
 heavy lift derrick, 118–121
 running, 86, 88
 screw, 89, 90
 sheer legs, 126
 stage, 73
 standing, 86, 87
 Right ahead, 2
 Right astern, 2
 Right hand laid rope, 62
 Righting capsized craft, 183
 lifeboats, 189
 liferaft, 227
 Rigid liferafts, 212
 access, 212
 capacity, 213
 construction, 212

- Rigid liferafts (*Contd*)
 davit launched, 214
 fittings, 213
 markings, 213
Rise of floor, 4
Rising, 172
Rogues yarn, 188
Rolling hitch, 70
Roll-on, roll-off, 162, 163
Roll-on, roll-off ship, 10, 13
Rolltite hatches, 152
Ropework, 59
 rope gauge, 86
 rope lay, 62, 84
Roping twine, 65
Rose seizing, 74
Round eye, 100
Round turn and two half hitches, 70, 71
Rowlock, 172
Royal standard, 257, 258
Rubbing strake, 168, 172
Rudder, 187
Runner, 107
Running bowline, 67, 68
- Safe handling of derricks, 112, 113
Safety supply/craft, 13
Sagging, 22
Sail, 6, 201
 marks on, 201
 parts of, 201
 terms, 6, 203
 theory, 201–203
 types, 6, 201
Sailmakers whipping, 77, 78
Samson post, 119
SART, 247, 248
Scantlines, 18
Schooner, 6
Scope, 44
Score, 93
Scotsman, 38
Screw eye bolt, 91, 92
Scuppers, 154
Sea anchor, 174, 175
Seaming twine, 64
Seattle hook, 110
Securing anchors to cable, 33
Securing hatches, 144
Securing Ro Ro cargo, 164
Seizings, 74
Seizing wire, 40, 85, 98
- Senhouse slip, 92
Sennet laid rope, 63
Serving, 75
 board, 75
 mallet, 75
Setting fid, 75
Service of
 hydrostatic release, 221
 liferafts, 228
Shackle
 joining, 30–33
 length, 44
 mousing, 97, 98
 parts of, 32
Shank, 25
Shearing stresses, 21
Sheaves, 98, 99
Shell plate, 17
Sheepshank, 71
Sheer, 3, 44
Sheer legs, 125, 126
Sheer strake, 19
Sheet anchor, 45
Sheetbend, 71
Ship, 1
 construction, 17, 20
 dimensions, 3
 stresses, 20, 21
 terms, 1–7
 types, 7–17
Shorten cable, 45
Short stay, 45
Shroud, 89, 90
Shroud laid rope, 62
Side bench, 168
Side frame, 17
Signal halyard, 65
Signal letters, 249
Signals, 250–256
Single anchor procedure, 39
Single letter meanings, 250
Single span derrick, 107
Single swinging derrick, 106, 107
Sisal rope, 60
Size of cable, 30
Size of rope, 86
Skates, 173
Sleeping cable, 51
Slewing guys, 111, 112
Slings, 72
Slip wire, 97
Small gear locker, 173
Small stuff, 63
- Snotters, 156
Snub, 45
Snug, 35, 38
Sockets, 90, 91
Soft laid rope, 62
Solid thimble, 92
Span block, 108
Spare anchor, 55
Spar ceiling, 150, 152, 154
Special cargoes, 154
Specifications
 lifebuoys, 231
 lifejackets, 229
Spider band, 107, 113
Spile pin, 31
Splay tackles, 126
Splices, 76, 93
 back, 76
 eye, 76, 93–95
 long, 76, 77
 short, 76, 77
Spreader, 158
Spring lay, 84, 85
Spun yarn, 64
Spurling pipe, 33, 35, 45
Stability expressions, 5, 6
Stage rigging, 73
Standard laid rope, 63
Standing block, 101
Standing rigging, 86, 87
Stay
 backstay, 91
 forestay, 86
 jumper, 89
 topmast, 86, 89
 triotic, 89
Staysail, 6
Stealer plate, 19
Steam guys, 118
Steam windlass, 34
Steel hatch covers, 146–156
Steel wire rope, 82, 83
Steering flat, 4
Steering oar, 174
Stem, 168
Stem band, 168
Stem post, 168
Stern, 12
Stern door, 10
Stern post, 168
Stock, 4, 25, 26, 58
Stockholm tar, 75
Stockless anchor, 25, 26

- Stoppers, 79, 80
 chain, 80, 81
 common, 79, 80
 West Country, 80
- Stowage
 factor, 153
 methods, 155
 wires on reels, 96, 97
- Strakes, 17
- Strand of rope, 59
- Stresses on derricks, 129–141
- Stretchers, 172
- Strops, 157
- Strum box, 145
- Stud, 31
- Stud eye, 100
- Stulken derrick, 121
- Summer loadline, 22, 23
- Surge, 45
- Survival craft, 204
- Survival manual, 174, 243
- Swallow, 98
- Swifter, 90
- Swivel head, 100
- Synthetic fibre rope, 65
- Tabernacle, 121
- Tack, 201
- Tacking, 201
- Tackles, 100–103
- Tackline, 249
- Talurit clamp, 92
- Tank cleading, 168
- Tank coatings, 9
- Tanker, 10, 165
- Tanker cargo plans, 164, 165
- Tank side bracket, 17, 145
- Tank top, 17, 145
 ceiling, 145
- ‘T’ bulb, 20
- Tarpaulins, 142–144
- Terms and definitions, 1–7
- Tests
 on anchors, 27
 on cable, 29
 on derricks, 125
- Thermal protective aids, 236
- Thimbles, 92, 93
- Thole pins, 173
- Three fold purchase, 103
- Thwart, 168, 172
- Thwart knee, 168
- Tide rode, 45
- Timber dogs, 157, 158
- Timber hitch, 70, 71
- Timber loadline, 24
- Timbers, 168
- Tonnage, 5
- Topmast stay, 86, 89
- Topsail, 6
- Topping derricks, 108–110
- Topping lift, 108, 109
- Totally enclosed boats, 180–204
 air support system, 184
 capacity, 181
 fire protection, 182, 184
 launching, 185, 196
 release mechanism, 183, 184, 185
 requirements, 182, 183
 water spray system, 184
- Training manual, 243, 244
- Transit bearings, 47
- Traveler, 188
- Triangular plate, 92
- Triatic stay, 89
- Tricing line, 215
- Tricing pendant, 190, 191
- Trigger, 191
- Tripping line, 175
- Tripping palms, 26
- Tropical fresh loadline, 22, 24
- Tropical loadline, 22, 24
- Trunnion, 120
- Tumblehome, 3
- Tumbler, 108
- Turnbuckle, 89
- Turn of bilge, 145
- Two letter signals, 255, 256
- Tyzack bar, 20, 143
- ‘U’ bolt, 112
- Ullage, 161
- Underdeck girders, 143
- Union hook, 110
- Union plate, 92
- Union purchase, 110–113
- Unit loads, 162–164
- Unstable, 5, 6
- Up and down, 45
- Upper block, 101
- Upper deck, 4, 7
- Upper tween deck, 7
- Veer cable, 45
- Vehicle stowage, 163, 164
- VHF use, 48
- Velle derrick, 116, 117
- Ventilators, 159
- Ventilation, 158, 159
- Warp threads, 257
- Watch at anchor, 46–48
- Water lay, 62
- Water pressure, 21
- Weak link, 218, 219
- Wearing, 201, 202
- Weft thread, 257
- Whippings, 77–79
- Winches, 36, 37
- Windlass, 33, 35, 36
- Wind rode, 45
- Winter loadline, 22
- Wire work, 82
- Wire rope, 83
- Yard, 254
- ‘Y’ mast, 115
- Yo-yo rig, 114
- ‘Z’ bar, 20
- ‘Z’ cargo block, 99

INDEX TO PART TWO



- Abandonment, 141–143
Abbreviations (IAMSAR), 209
Absolute temperature, 62
Accidents aboard tankers, 261, 263, 267
Accommodation fires, 168, 169
Accommodation ladder, 16, 19
Action of distress vessel, 189, 190
Active fin stabilisers, 225, 226
Adjustment of sextant, 32–34
Admiralty list of lights, 9, 11
 list of radio signals, 9, 11
 sailing directions, 9, 11
 tide tables, 9, 11
 weekly notices to mariners, 9, 10
Advance, 219–222
Advice for helmsman and OOW, 219
Aeration–echo sounder, 28
Aground, 110, 131, 145–147
Aircraft carrier, 126
Aircraft in distress, 192
Air cushion vessel, 126, 127
Alternative towing, 246
AMVER, 206–209, 299
Anabatic wind, 57
Anchor ice, 78
Anchor types, 275, 289
Anchor, use of, 75, 105, 109, 240
Anchoring, in emergency, 240
Anchoring large vessels, 274
Anemometer, 57
Aneroid barometer, 53–56, 57
Annual summary of notices to mariners,
 9, 10
Anschutz–gyro compass, 38–40
Anti-cyclone, 57
Arc of sextant, 30
Arming the lead, 26
Athwartships magnets, 41, 43
Atlantic weather areas, 66
Aurora, 57
AUSREP, 208
Automatic pilot, 6
Automatic resuscitation equipment, 266
Auxiliary steering gear, 163
Azimuth mirror, 48–50
Backing, 57
Balanced rudder, 213
Ballast, 254, 259
Baltic moor, 237, 238
Bar, 58
Bare ice, 78
Barograph, 56, 58
Barometer–aneroid, 55
Barometric tendency, 58
BCF (extinguishing agent), 181
 (bromochlorodifluoromethane), 181
Beaching, 145–148, 301
Beating out to seaward, 77
Beaufort weather notation, 68, 69
Beaufort wind scale, 67
Behaviour of vessels in heavy weather,
 72–75
Bells (ships), 123
Benefit of the lead, 26
Bergy bit, 78
Berthing, 230–231
Binnacle, 41–43
Black oils, 250
Blockage factor, 243
Boiler flue gases, 273
Bollards (bits), 227, 229
Boundary cooling, 174, 177, 179, 290
Bow/stern thrusters, 223–225
Brash ice, 78
Breast line, 227
Breathing apparatus, 183–185, 266
Breeches buoy, 196, 200, 201, 202
Bridge, 2, 6
Bridge layout, 2
Bridge wing lifebelt, 153, 154
Bridle (gangway), 16
Broach to, 74
Bulk cargo fires, 175
Bulk oil, 175
Bullring, 248
Bulwark ladder, 17
Buoyage IALA system A and B, 132–136,
 295
Buoyant smoke float, 199
Buoys–letting go from and securing, 136,
 232, 233
Butterworth (tank cleaning) machines,
 259, 260
Calling Master, 4, 5
Canal speed, 241, 242
Carbon dioxide CO₂ flooding, 178–181,
 187, 188, 251, 289
Cardinal marks, 134
Cargo fires, 185–188
Cargo (oil) handling equipment, 255
Cargo tank ventilation, 263, 264
Carriage of dangerous goods in ships, 14
Casualty rescue, 267
Cavitation, 210, 214
Centering error, 34
Certificates, 292–295
Chafing chain, 248
Chain bridle, 246
Checklist for passage appraisal, 2
Chemical fire extinguisher, 170
Chernikeeff log, 24
Chronometers, 35, 36
Clamp of sextant, 30

- Class of fire, 167
 Clean oils, 250
 Clearing berth, 230, 231
 CO₂ gas, 178–181, 187, 188, 251
 Coal fire, 186, 187
 Coastal forecast areas, 65, 70
 Coastguard services, 204–206
 Coastguard stations UK, 205
 Code of safe working practice, 9
 Code of safe working practice bulk cargoes, 10
 Cold front, 58
 Collimation error, 32, 34
 Collision, 137–141, 298
 Masters obligations, 137, 138, 298
 patch, 140
 Combined jet spray, 178
 Communications
 coastguard, 203, 204
 distress, 191, 192
 helicopters, 159, 299
 Compact ice edge, 78
 Compact pack ice, 78
 Compass, 37, 43
 bowl, 42, 43, 45
 card, 43
 correction, 46
 gyro, 36–40
 magnetic (dry card), 48
 magnetic (liquid), 42, 44, 45
 swing, 300
 Composite towline, 247
 Compulsory insurance, 278, 279
 Con, 210
 Concentration of ice, 78
 Condensation, 58
 Conduction, 58
 Consolidated pack ice, 78
 Constrained by draught, 95, 104, 108
 Construction of lead line, 25
 Construction of synoptic chart, 66
 Contingency plans, heavy weather, 69, 70
 Controllable factors of ship handling, 212
 Controllable pitch propeller, 215–217
 Convection, 58
 Corona, 58
 Correction of sextant, 32–34, 289
 Cotton fires, 186
 Crack in ice, 78
 Crash stop, 211
 Crude oil washing, 259–261
 Cyclone, 58
 Damage assessment, 137, 147, 302
 Damage stability data, 137
 Dangerous semi-circle, 76, 77
 Day signals, 121
 Dead beat compass, 44, 289
 Deck checklist following:
 beaching, 147
 grounding, 147
 Deck officers duties, 258–261
 tanker loading/discharging, 258, 259
 Deck seal (water), 272
 Deep draughted vessels, 95, 108, 291, 292
 Deep scattering layer, 29
 Deep tank fires, 176
 Degrees of freedom (gyro), 36
 Delayed turn, 155
 Density, 52, 53
 Department of Trade gangway, 19
 Depression, 71
 De-rat certificate, 292
 Deviation, 186
 Dew, 59
 Dew point, 59
 Diameter (of turning circles), 219, 221, 222
 Difficult ice area, 78
 Diffraction, 59
 Direction of buoyage, 136
 Dirty ballast, 254
 Distress, 191
 action by distressed vessel, 189–190
 Masters obligations, 190
 message, 192
 receipt of distress, 190, 191, 207, 208, 297
 signals, 114, 123, 197–201
 Dock water allowance, 52, 53
 Docking tug, 242, 245
 Doldrums, 59
 Double dunnage, 187, 188
 Double echo, 29
 Double turn, 155, 156
 Drag, 210
 Dredging down, 238
 Drift angle, 219, 223
 Drills, 141, 142
 Dry card compass, 48
 Dry dock–chief officers duty, 150, 151, 289
 Dry dock plan, 152
 Dry dock procedures, 150–153
 Dry dock–shore positions, 152
 Dry powder extinguisher, 167, 170
 Ducting, about propellers, 214
 Duties of:
 helmsman, 6, 7, 8, 211
 lookout, 5, 6, 88
 officer of watch, 3, 4, 8, 9
 stand-by man, 8, 9
 Dust explosions, 176
 Easy (ice) area, 78
 Echo sounding, 26–29
 errors, 28
 false echoes, 28, 29
 Elastic membrane (compass), 43
 Elliot White Gill–thrust units, 223–225
 Emergencies, 137
 Emergency, 137
 anchoring, 240
 boats crew, 154
 bridge lifebuoy, 153, 154
 plans and procedures, 252
 signals, 137, 153
 towing, 247, 248
 Enclosed spaces, 266–269
 Engine distance, 218
 Engine room department
 checks following grounding, 146, 147
 or beaching, 146, 147
 Englefield clip, 21–23
 Entering docks and locks, 232
 Entries into oil record book, 13
 EPIRB's, 193
 Errors of marine sextant, 32–34
 Escape sets, 266
 Etesian wind, 59
 Evacuation methods, 157
 Evaporation, 45, 59
 Evasive action for bad weather, 77
 Even keel (turning), 220
 Examination of pilot hoists, 17, 18
 Expansion chamber (compass bowl), 289
 Explosimeter, 250
 Explosions, 136, 252
 Explosive limits, 250, 252
 Explosives, 14
 Extinguishers, 167, 170
 Extinguishing agents, 167

- Fairleads, 227, 228
 False bottom, 28
 False echoes, 28
 Fans, 264
 Fast ice, 78, 79
 Fenders, 150, 232
 Final diameter, 219
 Fine on the bow, 5, 73
 Fin stabilizer control, 226
 Fin stabilizers, 225, 226
 Fire, 166
 Fire and explosion, 250
 Fire detection unit, 2
 Fire doors, 173
 Fire example cargoes, 185–188
 coal, 186, 187
 cotton, 185, 186
 fish meal, 187, 188
 LNG, 185
 Fire examples, 168–188
 accommodation, 168, 169
 cargo spaces, 174–177
 galley, 169–171
 machinery space, 171–173
 paint room, 177, 178
 small, 166
 triangle, 171
 Fire fighters, 166
 Fire fighting, 166
 First adjustment–sextant, 32
 First year ice, 79
 Fish meal cargo, 187, 188
 Fixed fire fighting installations, 178–182, 250
 BCF, 181, 182, 251
 carbon dioxide CO₂, 179–182, 251
 dry powder, 185, 251
 foam, 178, 250, 251
 steam smothering, 179, 251
 Fishing nets, 291
 Fishing vessels, 102, 103
 Fishing vessel signals, 103, 120, 121
 Fixed blade propeller, 215, 216
 Flame proof gauze, 255
 Flammable liquids, 14
 Flap rudder, 214
 Flashpoint, 249
 Flaw (ice), 79
 Flinders bar, 43, 46
 Floating ice, 79
 Floating link, 162
 Floe (ice), 79
 Floeberg, 79
 Flooding, 139, 140
 Foam extinguisher, 170
 Foam fixed extinguisher, 251
 Fog, 59, 304, 305
 Following sea, 74
 Forecast areas, 64, 65
 Fracture (ice), 79
 Frame of sextant, 30, 31
 Free gyroscope, 36, 37
 Fresh water allowance, 53
 Frog, 22, 23
 Fronts, 69
 Fusee drum, 35
 Ganger length, 238
 Gangway (DoT), 19
 Gangways, 19
 Gale, 59, 67
 Galley fire, 169, 170
 Gas detector, 267
 Gas lines, 254
 Gas protection suit, 266
 Gather way, 212
 General declaration, 147
 General duty–watchkeeping, 3, 5–9
 General (tanker) operations, 249
 Gimbals, 35, 36, 45, 46
 Girding (girding) a tug, 243, 245
 Glacier, 79
 Gnomonic projection, 295
 Gob rope, 244, 245
 Gong, 123
 Governor, 21, 22
 Graduation error, 34
 Grey ice, 79
 Grounded ice, 79
 Grounding, 145
 Growler, 80
 Guest warp, 144
 Guidelines–marine safety card No. 1, 268–271
 Guide line, use of, 267
 Gulf stream, 59
 Gyro compass, 36–40
 Gyroscopic inertia, 37
 Hail, 59
 Halo, 60
 Halon, 178, 181–182
 Hand flare, 198
 Hand lead, 25
 Hand smoke, 200
 ‘Hand’ the log, 23
 Hawser (breeches buoy), 201, 202
 Haze, 60
 Head lines, 227
 Heading how is she, 124
 Head on situations, 94
 Headreach, 210
 Health and safety (aboard tankers), 261–263
 Heat shield, 175, 177
 Heaving to, 74, 300
 Heavy weather, 69, 71, 72–77
 Heeling error magnets, 46
 Helicopter procedures, 156–161, 299
 Helicopter strop, 159
 Helm orders, 8
 Helmsman, 6, 7, 210
 advice, 6, 7, 219
 duties, 6, 7, 8
 HM Coastguard, 204, 205
 Hoists, 17
 Horizon mirror, 32
 Horizontal magnets, 46
 Horse latitudes, 60
 Hose action, 174–178
 Hose boxes, 173
 Hovercraft, 126, 127
 Humidity, 60
 Hummock ice, 80
 Hurricane, 60, 67, 76, 77
 Hydrants, 173
 Hydraulic steering, 161, 162
 Hydrocarbons, 264–267
 Hydrometer, 52–53, 60, 255
 Hygrometer, 53, 60
 IALA buoyage system, 132–136, 295
 IAMSAR, 10, 209
 Ice, 60
 damage, 84, 85
 navigation, 83–85
 strengthening, 84, 302
 terminology, 78
 types, 78–82
 Icing up, 67
 Ignition point, 252
 Ignition sources, 251, 252
 IMDG code, 14
 IMO, 86
 Impellor log, 24, 25
 Inclinator, 43

- Inconspicuous partly submerged object, 101
- Index arm, 30
- Index error, 32–34, 289
- Index mirror, 30, 32
- Indicator buoys (submarine), 164, 165, 297, 298
- Inert gas, 254, 264
- Inert gas systems, 269–274
- Inhalation of hydrocarbons, 265
- Instrument error, 34
- Insurance, 278, 279
- Insurance certificate, 279
- Insurance wire, 247
- Interaction, 240–244
- International code of signals (INTERCO), 10, 12, 209 (see Part 1, for flag recognition (identity))
- International shore connection, 183–185
- Intrinsically safe, 252
- Iridium pivot, 44, 48
- Isobars, 60
- Isolated danger buoy, 135
- Isotherms, 60
- Jack stay, 201
- Jayhawk helicopter, 160
- Jet/spray, 178
- Jumping buoys, 229
- Jury rudders, 161
- Jury steering, 163
- Katabatic wind, 61
- Keel, 153
- Keel blocks, 151, 152, 153
- Kerosene, 250
- Key (tail end shaft), 216
- KM (dry dock formula), 153
- Ladders, 15–20
- Land and sea breezes, 61
- Landing areas for helicopters, 157
- Landing-on helicopter checks, 160, 161
- Large tankers, 249
mooring, 274–276
towing arrangements, 247, 248
- Lateral marks, 133
- Lead (ice), 81
- Lead line, 25, 26
- Leadsman, 26
- Leakage, oil, 277, 278
- Letting go from buoys, 233
- Level ice, 81
- Lifeboat use, 194, 195, 196
- Liferaft use, 193, 195
- Light and smoke marker, 201
- Lightening, 252
- Light lists, 9, 11
- Lights (navigation), 97, 115–120
- Lines of magnetic force, 46
- Line throwing apparatus, 144, 194, 202, 203, 289
- List, 210, 222
- Liquid magnetic compass, 44–46, 289
- LNG fires, 185
- Loading (tanker) procedure, 276–278
- Local direction of buoyage, 136
- Location aids, 196–201, 203, 204
- Log, 21
impeller type, 24, 25
rotator type, 21–24
- Logline, 23, 24
- Long distance towing, 244
- Lookout, 9, 88
duty, 5, 6
field of view, 5, 291
- Loss of rudder, 161–163
- Lubber line, 47, 51
- Machinery space fires, 171–173
- Magnetic compass, 41–51
- Making way, 212
- Manifold, 254
- Manropes, 15
- Manoeuvring signals, 111
- Man overboard, 153–156, 294
- Marine instruments, 30
- Marine safety card No. 1, 270, 271
- Marine sextant, 30–34
- Mariners handbook, 11
- Maritime rescue co-ordination centres UK, 70
- Marks on lead line, 25
- Masons hygrometer, 53
- Masters' obligations in distress, 138, 190
- Masters responsibilities, 1
- Mechanical hoists, 17, 18
- Merchant shipping notices, 10
- Meteorological terms, 57–65
- Meteorology, 57–86
- Micrometer sextant, 30, 31
- Mine clearance vessels, 108
- Minerva fire detection unit, 2
- Mirage, 61
- Monsoon, 61
- Mooring, 233
Baltic moor, 237
Mediterranean moor, 238, 239
open moor, 236
running moor, 233, 234, 235
standing moor, 235–236
- Mooring lines, 227
- Mooring swivel, 236
- Mooring systems, 227, 275, 276
- Motive power, 220
- Multi angled fairlead, 227
- Multi-year ice, 81
- Narrow channels, 90, 241
- Nautical almanac, 12
- Nautical tables, 12
- Navigable semi-circle, 76
- Navigational warning, 191
- Navigational watchkeeping, 1–9
- New dangers, 295
- New ice, 81
- Nilas, 81
- Nip, 82
- Non-adjustable errors of sextant, 34
- Non-displacement craft, 128
- Non-persistent oil, 278
- Non-return valve, 272
- North Atlantic weather forecast areas, 66
- Notices to mariners, 9, 10
- Not under command, 103, 105
- Nozzles jet/spray type, 178
- Obligations of rescue craft, 190
- Officer (watchkeeping) duties, 3–6
- Official publications, 9–14
- Offshore anchor, 275, 289
- Offshore installation, 127
- Oil, 278
fires, 249
pollution, 276, 278–284
pollution manual, 10
pollution participating countries, 287
to the convention
record book, 12, 13
references, 285, 286
residues, 279

- rigs/platforms, 127, 128
 tankers, 249, 250
 Oil water separator, 279
 Old man/deadman, 227
 On scene co-ordinator OSC, 204, 207–209
 Open moor, 236
 Open pack ice, 82
 Open water, 82
 Operating in ice conditions, 83, 84
 Overtaking, 93
 Oxygen analyzer, 265
 Oxygen-in fire, 171

 Pack ice, 82, 85
 Paint room fire, 177, 178
 Pair trawling, 121
 Panama lead, 228, 248
 Pancake ice, 82
 Passage appraisal, 2
 Passenger vessel emergency, 142, 143
 Patent rotator log, 21
 Pelorus, 50, 51
 Period of encounter, 71, 72
 Performance monitor (radar), 290
 Period of roll, 71, 72
 Permanent ballast, 254
 Persistent oil, 278
 Phosphorescence, 61
 Pilot books, 11
 Pilot hoists, 17–20
 Pilot ladders, 15–20
 Pilot vessels, 104, 105, 131
 Pilot wheels, 7
 Pipelines, 254, 262, 263
 Pitch (of propellers), 211, 219
 Pitching, 72
 Pivot (compass) point, 44
 Pivot point, 211
 Plug plan, 152
 Plugs, 151
 Polar front, 61
 Pollution, 276, 277
 incidents, 279
 precautions against, 276–281
 references, 285, 286
 regulations resume, 283
 Pooping, 73
 Pounding, 73
 Precession, 37
 Precipitation, 61, 71
 Precision aneroid barometer, 53–56
 Preferred channel marks, 133, 134

 Pressure vacuum breaker, 269
 Preventing collision at sea, 86
 Principle of echo sounder, 26–28
 Principle of sextant, 31
 Prismatic error, 34
 Production platforms, 127, 128
 Prohibition of oil discharge, 282, 283
 Propellers
 controllable pitch, 212, 216
 fixed pitch, 212, 215, 216, 240
 propeller removal, 150
 propeller slip, 217, 218
 Protective equipment, 266
 Pump room precautions, 266–271
 Pump room rescue, 267
 Purge pipe, 264
 Purse seiners, 120, 121
 Pyrotechnics, 196–201
 Pythagorean error, 28

 Quadrantal correctors, 43, 45, 46
 Quadrant steering, 163
 Quartermaster, 6, 211
 Quayside mooring, 227
 Questions and answers, 289–307

 Radar reflectors, 4, 136
 Radiation, 61
 Radio signals, 9, 11
 Rafted ice, 82
 Rain, 61
 Rainbow, 62
 Ranging (on moorings), 241
 Reaction fin, 214
 Reception of slops, 279
 Recurvature of storm, 62
 Reduction of speed, 90, 168
 Refined product carrier, 250
 Reflector (compass) unit, 47
 Refraction, 62
 Regulations, for the prevention of, 86
 Annex I, 115
 Annex, II, 120
 Annex, III, 121
 Annex, IV, 123
 Collision at sea, 88–88
 conduct of vessels in, 95
 Part A–General, 86–88
 Part B–Steering and sailing rules, 88–96
 Part C–Lights and shapes, 96–111
 Part D–Sound and light signals, 111–114
 Part E–Exemptions and annexes, 114, 115
 restricted visibility
 (Section I), 88
 (Section II), 93
 (Section III), 95
 Remote controlled craft, 129
 Rescue and recovery, 143–145
 Rescue of casualties, 172, 266, 267
 Restricted in ability to manoeuvre, 103, 106–107
 Ridge, 62
 Riding cable, 235, 236
 Rigging pilot ladders, 15–20
 Rigging slip wires, 228, 229
 Rigidity in space, 37
 Rocket line throwing gear, 202, 203
 Rocket parachute flare, 197
 Roller fairlead, 227, 228
 Roll-on, roll-off vessel emergency, 143, 195
 Rotary vane steering, 162
 Rotator log, 21–23
 Rotten ice, 82
 Rudders, 213
 angle, 222
 carrier, 163
 loss, 161–163
 stock, 163
 Rudder types, 213
 balanced, 213
 flap, 214
 plate, 213
 rotor, 214
 schilling, 214, 215
 semi-balanced, 213
 spade, 213
 un-balanced, 213
 Rule of the road: questions and answers, 129–132
 Safe entry, 266–271
 Safe handling tows, 243
 Safe port options, 140
 Safe speed, 88, 89
 Safe water mark, 135
 Safety checklist–helicopters, 156, 157, 159–160
 Safety construction certificate, 292, 293
 Safety equipment certificate, 292, 293

- Safety officer/safety committee, 306, 307
- Safety radio certificate, 292, 293
- Sailing directions, 9, 11
- Sailing vessels, 93, 102
- SART's, 191, 192, 209
- Schilling rudders, 214
- Scrambling nets, 143
- Screens (sidelights), 117
- Scrubbing tower, 273
- Sea anchors, 75, 76
- Sea ice, 82
- Seaplane, 111, 128
- Search and rescue operations, 191
- Search patterns, 191
- Sea-sickness medicine, 174, 210
- Securing propeller, 216
- Securing to buoys, 228, 229, 232, 233
- Separation schemes, 92
- Semi-balanced rudder, 214
- Set, 211
- Sextant, 30–34
- Shade error, 34
- Shadow pin, 50
- Shallow water effect, 241, 242
- Sheer, 211
- Ship handling
 - factors, 212
 - in ice conditions, 83, 84
- Ship/shore connection, 183
- Ship to shore (tanker) checklist, 253
- Shoring up bulkheads, 140
- Short round, 234
- Shoulder post, 246
- Side keel blocks, 152
- Sidelights, 99, 116, 117
- Sighting port spanner, 253, 256
- Single point mooring, 275, 276
- Skin contact by hydrocarbons, 264, 265
- Slack tanks, 276, 277
- Sleeping cable, 235, 236
- Sleet, 62
- Slip of propeller, 217, 218
- Slip wires/ropes, 228, 229
- Slops, 279
- Small fires, 166
- Smoke signals, 199–201
- Snow, 62
- Snubbing round, 239
- Sounding, 256
- Sounding rod, 255
- Sound signals, 121
- Spade rudder, 213
- Specialized carriers, 250
- Special cases to Rule of the Road, 125–127
- Special marks, 135
- Special operations Ro Ro vessel, 195
- Specific gravity, 255
- Sphere correctors, 43, 45, 46
- Spontaneous combustion, 177, 186, 187, 252
- Squall, 62
- Squat, 211
- Stabilizer fins, 226
- Stanchions, 15
- Standing moor, 235, 236
- Steam smothering, 179
- Steel tape measure, 255
- Steering gear, 161–163
 - failure, 163
 - types, 163
- Stern light, 97, 98
- Stern lines, 227
- Stern thruster, 223, 224
- Stern to sea, 73, 74
- Stevenson's screen, 53
- Stiff ships, 71, 73
- Stopping distance, 211
- Storm movement, 77
- Stowage factor, 291
- Stranded ice, 82
- Stranding, 145
- Stratosphere, 62
- Stuffing box, 163
- Sub-sunk buoys, 165
- Sub-sunk procedure, 164, 165
- Surface rescues, 193–196
- Surrounding a fire, 169
- Survivors, 143–145
- Swell, 68
- Synchronism, 72
- Synoptic weather chart, 71
- Tabular berg, 82
- Tackling a fire, 169
- Tactical diameter, 219
- Taking the ground, 145–147
- Tank, 256
 - cleaning, 260, 261
 - gauge, 257, 258
 - layout, 262, 263
 - lid, 262
 - lid plan, 262
 - measurement, 256
- Tanker, 142
 - hazard, 142
 - safety guide, 253
 - vessel, 249
 - work, 249–286
- Technical detail: lights and shapes, 115–120
- Telemotor transmission, 162
- Telescopic compass reflector unit, 47
- Tender ship, 71
- Temperature, 62
 - can, 256
- Testing mechanical hoists, 18
- Test meter (oxygen), 265
- Third adjustment sextant, 32–34
- Thrust units, 223–225
- Thunder, 62
- Tidal stream atlas, 9, 12
- Tide tables, 9, 11
- Tiller, 162
- Tipsy key, 35
- Tornado, 63
- Torque, 35
- Towing, 195, 243–248
- Towing and pushing, 99–102
- Trade winds, 63
- Traffic separation schemes, 92
- Training and drills, 141
- Transfer, 219, 221
- Transfer of oil, 279, 281
- Transmission line error, 28
- Tropical revolving storms, 76, 77
- Tropopause, 76
- Trough, 63
- Tugs, 242–248
- Turning circles, 219–223
- Turning short round, 234
- Tween deck fires, 174
- Twilight, 63
- Twin screw propulsion, 216, 217
- Types of rudder, 213
- Ullage, 256
 - pipe plan, 262
 - stick, 256
- Unbalanced plate rudder, 213
- Underway, 212
- Union purchase, 294
- United Kingdom buoyage direction, 136
- UK buoys, 136
- UK coastal forecast, 64
- Universal multi-angled fairlead, 228

-
- Urgency signal, 191
 - Use of anchors, 75
 - Use of sea anchors, 75
 - Use of storm oil, 74, 75
 - Use of tugs, 242

 - Veering, 63
 - Ventilation, 264
 - Vent valves, 263, 264
 - Vertex, 63
 - Very close pack ice, 82
 - Very large crude carrier, 249
 - Vessel, 87

 - Vessel in distress, 189
 - Virtual loss of GM, 152, 153
 - Visibility, 63
 - Visibility of lights, 97
 - Volatile liquid, 249

 - Warships, 125–126
 - Warm front, 63, 68
 - Watchkeeping duties, 3–9
 - Watertight doors, 148, 149
 - Watertight integrity, 147
 - Water wall system, 251
 - Washing cycles, 261

 - Wave scale, 67, 68
 - Way, 212
 - Weather chart, 64–66, 71
 - Weather report codes, 67, 68
 - Weather side, 212
 - Weekly notices to mariners, 9, 10
 - Wheel key, 254, 257
 - Whesoe tank gauge, 257, 258
 - Whistles, 121, 122
 - Wine carrier, 250
 - Winnets, 17

 - Yaw, 212