BULK CARRIER PRACTICE

Captain J Isbester FNI MRIN
Extra Master

Foreword by Dr Frank Chao, Chairman, Intercargo

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This book has been prepared to address the subject of bulk carrier practice. This should not, however, be taken to mean that this document deals comprehensively with all of the concerns which will need to be addressed or even, where a particular matter is addressed, that this document sets out the only definitive view for all situations.

the opinions expressed are those of the author onlv and are not necessarily to be taken as the policies or views of anv organisation with which he has anv connection.

Readers and students should make themselves aware of anv local, national or international changes to bylaws, legislation, statutory and administrative requirements that have been introduced which might affect some conclusions.

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Notes on numbering of illustrations and appendices

All illustrations and appendices are numbered in one sequence consecutively within the chapter in which they appear or to which they relate-e.g., FIG 1.5, denotes figure 5 in chapter 1 and will be found in the main text of the book; APPENDIX 10.1 denotes appendix 1 relating to chapter 10 and will be found in the collection of appendices at the back of the hook.

FOREWORD

DRY BULK CARRIERS, the workhorses of the sea, carry out the essential transport of commodities without which our modern society would not be able to function. The ships and their crews, together with the companies that operate them, do not enjoy the glamour attached to other sectors of the industry more in the public eye; the bulk shipping sector does, however, provide a highly cost-effective service for which proper recognition is due. This quiet matter-of-fact 'let us get on with the job' approach so prevalent in bulk carrier companies belies the professionalism implicit in the operation of bulk carriers and perhaps leads others to undervalue its major contribution to the world economy.

It is not until somebody of the calibre of Captain Isbester, supported by the Bulk Carrier Working Group of The Nautical Institute, puts operational practice into writing, that the reader becomes aware of the knowledge, expertise and skill necessary to run bulk carriers efficiently and safely. The 26 chapters of this book break new ground. They focus not only on operational requirements but also on the various decision-making processes necessary for successful operation.

This approach separates this publication from others in the field and provides its unique character. The task of compiling such a book is very much more difficult than simply writing a textbook on a specific theme, such as charterparties. But once achieved, it is essential for reference and study. Clearly it will be used both on board and in a company's daily operations. It will also be an effective training manual for all those joining the world's bulk fleet for the first time. More widely, it will be of particular value to shippers and charterers, terminal operators, surveyors, consultants and maritime lawyers.

The 400 pages of the book encapsulate the essence of good economic performance and professional awareness of all the contributory factors which go towards optimum stowage and discharge, and thus to a successful voyage. This entails meeting the charterparty requirements without claims arising, whilst still ensuring that the vessel is at all times ready to trade.

Operating successfully and profitably is no mean achievement in today's turbulent trading conditions. It therefore gives me great pleasure to write this foreword. The advice and information the book contains will not only ensure high standards of operation, but will provide a means for reducing claims and containing risk. Well presented, in straightforward language and intelligently illustrated, the book has a persuasive authority which will stimulate interest and commitment.

Dr Frank Chao
Chairman, Intercargo;
President, Wah Kwong
Shipping, Hong Kong

INTRODUCTION

THIS BOOK is an attempt to gather into a single volume all the specialised knowledge and experience which a master and his deck officers require if they are to operate bulk carriers safely and efficiently. The emphasis throughout is on the dry bulk trades, and matters such as navigation, ship handling and safety have in general been discussed only where they apply specifically to bulk carriers.

The reader has been assumed to have an adequate knowledge of ships, seamanship, navigation, stability and nautical terms, but no previous experience of bulk carriers. Every effort has been made to use plain English for the benefit of the many seafarers for whom English is a second language.

Whilst written primarily for the bulk carrier master or officer who wants to increase his knowledge, the needs of shipowners, ship operators, nautical college staff, naval architects, marine consultants and surveyors, average adjusters, maritime lawyers and regulatory authorities have not been forgotten. The book contains much in the way of practical operating procedures which is likely to be useful to these categories of reader.

The methods and procedures described are those followed by shipping companies, masters and senior officers who run hard-working ships with competent officers, adequate manning, and sufficient stores and spares. The standards described are high, but not unrealistic, and are necessary if ships are to be operated safely and efficiently and maintained in good condition.

For readers who have a thorough understanding of bulk carrier operations and simply require a reminder of good working routines, the checklists which end many of the chapters provide an easily readable summary of tasks and procedures. A full explanation of why and how each task is done is to be found in the body of the book, whilst the appendices provide worked examples of calculations and detailed treatment of some specialised matters.

The appendices containing the basic stability calculations have been prepared with care. Every effort has been made to give full guidance as to how these calculations can be completed. They have been provided because the explanations given in loading and stability manuals are often inadequate.

The mv *Regina Oldendorff,* a handy-sized geared bulk carrier has, by kind permission of her owners, been used as an example to illustrate points throughout the book. The range of cargoes for which she was designed and her excellent condition of maintenance made her very suitable for that purpose. My own background and those of the experienced bulk carrier masters and officers who advised me have ensured that the working practices described in the book are appropriate for all sizes of bulk carrier and not limited to the handy-sized vessel or any other single category.

Several of the builders' drawings of the *Regina Oldendorff have* been reproduced for reference. To fit them in this book they have been much reduced in scale. In general, the comments made about them can be understood without the need to read the small print, but readers who want to study the detail can do so with the help of a magnifying glass, or of an enlarged copy taken with a photocopier.

I had hoped to use standard abbreviations for the stability terms used in the book, but stability manuals from different sources use a bewildering variety of abbreviations for the same value, as is shown in Appendix 10.1. There is an obvious need for international standardisation of abbreviations for stability purposes. In most cases stability terms have in this book been stated in full to avoid confusion.

Metric units have been used throughout the book, with Imperial equivalents also given when they are often used. Although the Systeme International d'Unites (SI) has been the system of measurements adopted officially by the major maritime nations since the 1960s its introduction within shipping has been slow, and it remains normal in the industry to speak of 'weight' rather than 'mass'. I have followed common practice, and written of weight.

The title of this book, *Bulk Carrier Practice,* consciously echoes that of *Tanker Practice* written by Captain G A B King in 1956. Captain King's is an outstanding text book which was welcomed by generations of students, junior officers and newcomers to the business of operating tankers. With the encouragement and help of The Nautical Institute I have sought in this book to provide a similarly authoritative manual for those with an interest in bulk carriers.

There is one significant difference between the shipping industry in the 1950s and that of the 1990s. Captain King wrote for officers drawn, in most cases, from traditional maritime countries with well established schemes for officer training. Nowadays, most officers, particularly on bulk carriers, come from Third World countries where traditions of training for the sea are more recent and diverse. When providing explanations in this book I have tried not to assume too much knowledge and experience in the reader.

The dry bulk trades, by virtue of the variety of ships used, cargoes carried and ports visited, make considerable demands upon the skill, experience, resourcefulness and determination of those who man the ships. Whilst talking to the many bulk carrier masters and officers, past and present, who have advised me I have been conscious of their eagerness to pass on their hard-earned expertise, and to help those with less experience to operate their ships safely and competently. That is the main purpose of this book, and to those readers who are serving on bulk carriers, or preparing to do so I send my best wishes for voyages made safer, more efficient, more successful and therefore more enjoyable by a careful reading of the appropriate chapters!

There is always room for improvement in a book such as this and corrections and suggestions for new procedures or material to be included in any possible future edition will be welcome.

Jack Isbester
October 1993

Front cover photograph

Part of the cargo of grain from the Panamax-sized bulker *Adriatic Skou* (72,000 dwt), berthed alongside in Antwerp, is being transhipped by gantry-mounted grabs to the handy-si/ed *Eglantine* (31,000 dwt) berthed outside her.

Photograph: Foto Guido-Coolens Antwerp, reproduced by courtesy of ABT, Antwerp Bulk Terminals

ACKNOWLEDGEMENTS

A BOOK with the range and depth of *Bulk Carrier Practice* can only do justice to the subject if information is available from numerous sources. It has been my good fortune to write this book for The Nautical Institute, a body with an unrivalled wealth of experience amongst its membership in the operation of bulk carriers. Much of that experience has been put at my disposal by members who have provided information, contacts and advice, and I have been fortunate in receiving generous assistance from a number of very capable and experienced colleagues.

Captain Peter Roberts, BSc, FNI, and **Captain Les Hesketh, MNI,** both serving shipmasters, have read the entire book chapter by chapter as it was written and provided me with a very considerable number of constructive comments which demonstrate their commitment to best operating standards and the practical approach they both employ. A third serving shipmaster, **Captain Francois Hugo,** FNI, spent weeks of his spare time in designing a set of documents for all the standard deadweight, trim, stability and stress calculations, and supporting them with a comprehensive set of worked examples and explanations. He also checked all the other calculations which the book contains.

Captain Peter Boyle, FNI, and Captain Eric Beetham, FNI, FRSA, FRMetS, FRIN, like Peter Roberts and Les Hesketh, were members of the Bulk Carrier Working Group which guided the project and gave me much useful advice. In addition Peter Boyle provided much of the information for Chapter 21, whilst Eric Beetham wrote the text and provided the illustrations for the section on combination carriers. **Captain Peter Swift, FNI, and Dennis Barber, MNI,** were also members of the Working Group who could be relied upon for prompt information, assistance and support when it was needed.

When seeking a shipowner with a modern versatile handy-sized bulk carrier which I could use to illustrate the text of the book I was fortunate to meet **Mr Henning Oldendorff** of Egon Oldendorff. He and his staff, particularly **Mr D. Kannenberg,** were immensely helpful to me, and it was a pleasure to visit mv *Regina Oldendorffm* Liverpool and to note the immaculate condition in which she was maintained, as illustrated by the photos in the book.

Tony Vlasto and Paul Dickie, solicitors with Clifford Chance, provided very necessary advice about the legal aspects of charterparties and cargo documents, and **Captain Richard Evans** brought to my attention many commercial considerations for the same two chapters. **Keith Taylor, BSc, CEng,** managing director of MacGregor-Navire (GBR) Ltd, provided considerable assistance with Chapter 4. **Captain Geoff Cowap, ExC, MPhU, MRIN, MNI,** gave generously of his time to put the hydrostatic characteristics of the *Regina Oldendorff* into a computerised loading program.

I am indebted to many other people for their contributions on particular topics or their assistance in improving my text. Amongst former colleagues from Jebsens Ship Management Ltd I am particularly grateful to **Simon Evans, MIMarE,** for advising me from the chief engineer's point of view, to **Captain Derek Clements,** MNI and to **Captain Steve Barnet,** MNI, for practical information on a variety of topics, to **Captain Tony Gatt, MNI,** for welcoming me aboard mv *Telnes,* and to **Captain Allan Brown,** MNI, for the prompt provision of useful information.

Captain David Greenhalgh, MNI, revealed his experience of log carriers in a letter to *Lloyd's List* and was then prevailed upon to provide notes on that subject for the book. **David Phipps** of Arlona Engineering in Durban supplied notes upon the cocooning of cargoes and the use of grabs. **David Robinson, BSc, CEng, MRINA,** a principal surveyor at Lloyd's Register and chairman of the IACS working party on hull damages, and his colleagues provided much useful advice on safe loading procedures and the avoidance of damage to bulk carriers.

Dr lan Dand, CEng, BSc, PhD, FRINA gave advice and encouragement on Chapter 8. **John Stott, CEng, MA, BSc, MIMarE, FInstR,** improved my words on ventilation and applied his usual scrupulous standards to the text. **Captain Ken Harper, FNI,** provided invaluable notes on the measurement and transportation of forest products, and for authoritative advice on the carriage of steel I was able to consult Arthur **Sparks, MNI. Jerry Colman, FRINA, MRIN, CEng,** and his colleagues provided advice on several stability matters, and on bulk carrier losses.

Captain Kelvin Ferries, MNI, supplied information about Munck gantries, whilst **Captains John Houghton,** FNI, and **Gordon Mackie, FNI,** gave me data and advice about weather routeing services. To **Captains Angus McDonald, FNI,\Francois Baillod, MNI, Andrew Tinsley, MNI, John David, MNI, and Gordon Blythe,** MNI, I am indebted for thoughtful advice based upon their varied personal experience. **Douglas Foy,** FNI, has a long and creditable record of drawing attention to the scandal of bulk carrier losses, and I have been encouraged by his support and assistance. The Nautical Institute's *Seaways* magazine, and in particular its letters section, has also been enormously useful to me as a source of sound professional opinion.

For advice, information and encouragement I am grateful to **Captain Tim Lant, Mr O. H. J. Dijxhoorn** of the **IMO, Donald J. Sheetz,** MNI, **Captains lain Steverson,** MNI, **Chris Colchester, MNI,** and **Sam Household, FNI,** to **David Ralph** of the DOT and **Derek Maidment** of BMT Cortec Ltd, to **Richard Clarke, BComm,** MNI, **Kenneth Long, BSc, FICS, FNI, MCIT, Phil Anderson, FNL** and **Karl Lumbers, MNI.**

I am deeply indebted to **Julian Parker, BSc,** FNI, Secretary of The Nautical Institute, for his unfailing support and encouragement during the three years during which this project has matured, to **David Sanders,** ExC, FNI, production editor, for his skill in making the very best of the material provided, and to **Lieutenant-Commander Mike Plumridge,** FNI, RN, Deputv Secretary, for arranging for my attendance at several relevant seminars.

To **Captain Peter Lyon, FRIN,** MNI, my partner at Eagle Lyon Pope Associates, I offer my thanks for the patience and generosity with which he has accepted my extended absence from our consultancv-a period during which our office became, for me, hardly more than a photocopying agency! I am also grateful to him for improvements to Chapter 11—The Loading/Discharging Berth.

My wife **Audrey** is no expert on bulk carriers, and her contribution to the book cannot be identified within its pages. However, the book would never have been written were it not for the generosity, tolerance and equanimity with which she kept the household running during the last three years even accepting, with hardly a hint of protest, that when we went on holiday the word processor went with us! I owe her a verv substantial debt of gratitude.

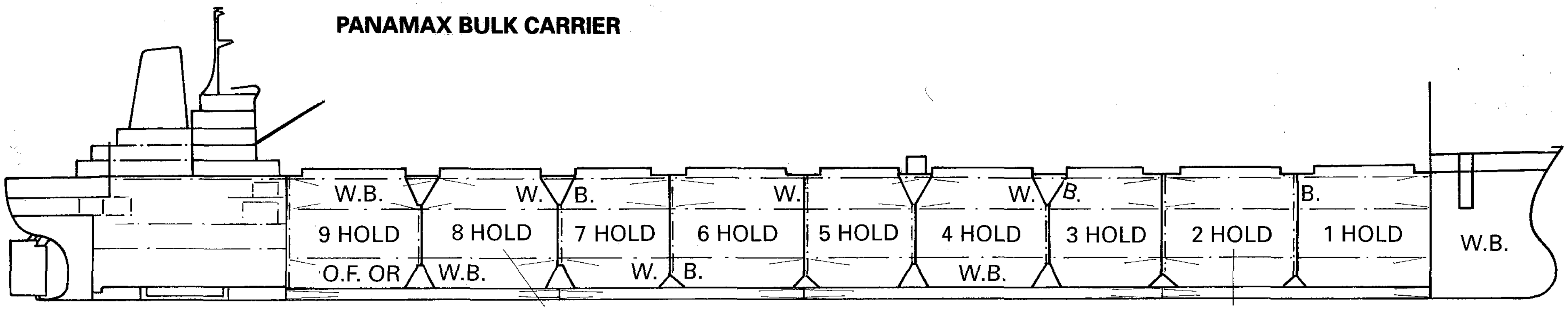
My debt to all those mentioned above, and to any others I may have forgotten, is considerable. If the book contains errors the fault is mine.

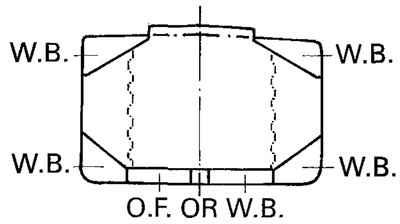
Jack Isbester

Photographs and diagrams

Photographs of the Regina Oldendorff *in Liverpool are* © fry *Tangent Commercial Photography, Merse\side L64 3U(j.*
Diagrams drawn fry *David Henderson. Additional artwork by Brian Mehl.*

PANAMAX BULK CARRIER

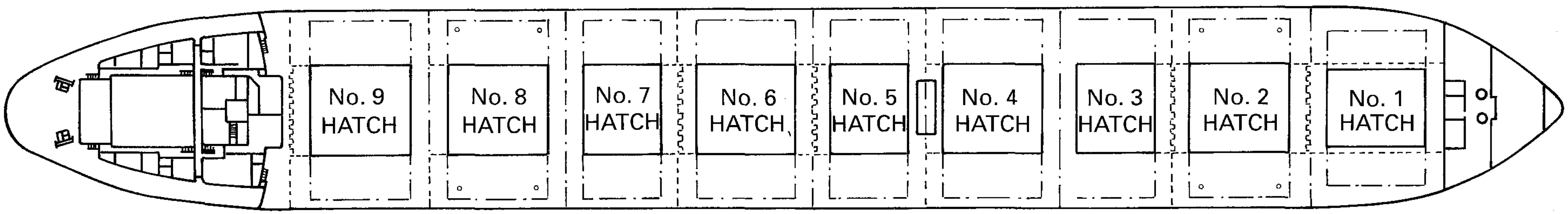




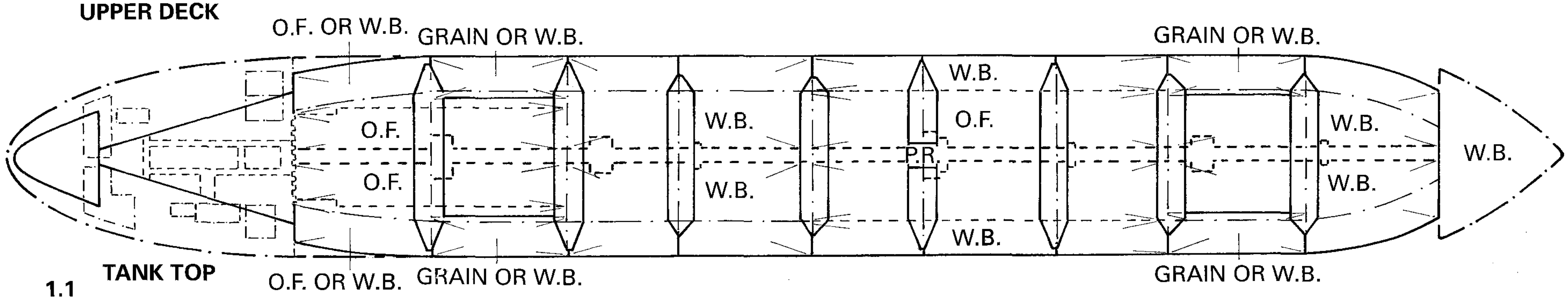
MIDSHIP SECTION

Principal Dimensions

Length Overall	246.6	metres
Breadth Moulded	31.7	metres
Depth Moulded	19.2	metres
Summer Draft	14.5	metres
Deadweight on Summer Draft	78,500	tonnes
Service Speed	14.6	knots



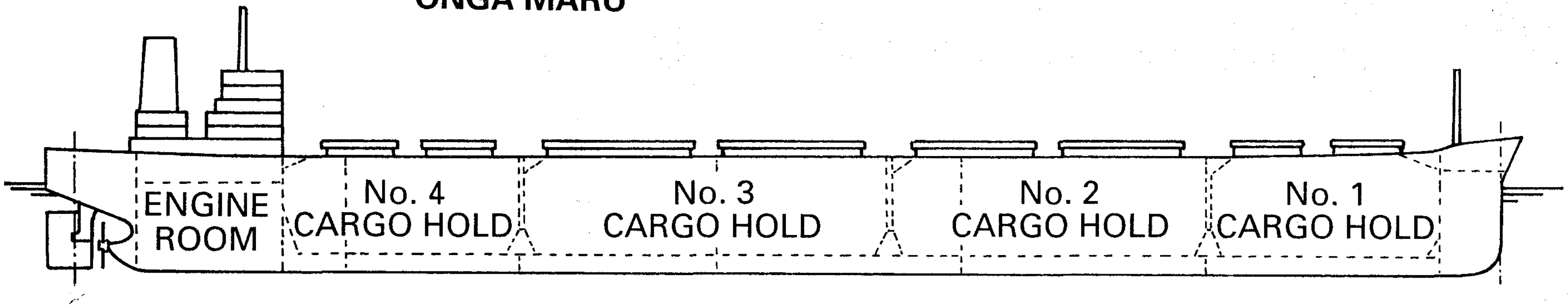
UPPER DECK

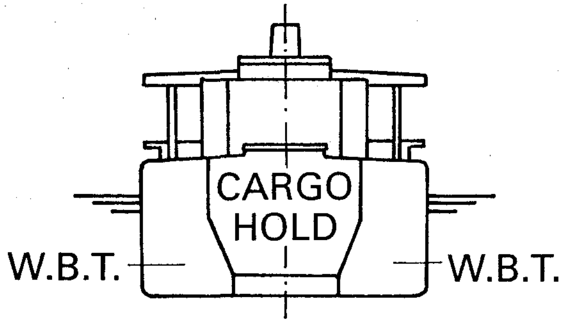


TANK TOP

1.1

198,900 DWT ORE CARRIER
ONGA MARU





Principal Dimensions

Length Overall	300.0	metres
Breadth Moulded	50.0	metres
Depth Moulded	24.3	metres
Summer Draft	18.0	metres
Deadweight on Summer Draft	198,900	tonnes
Service Speed	13.5	knots

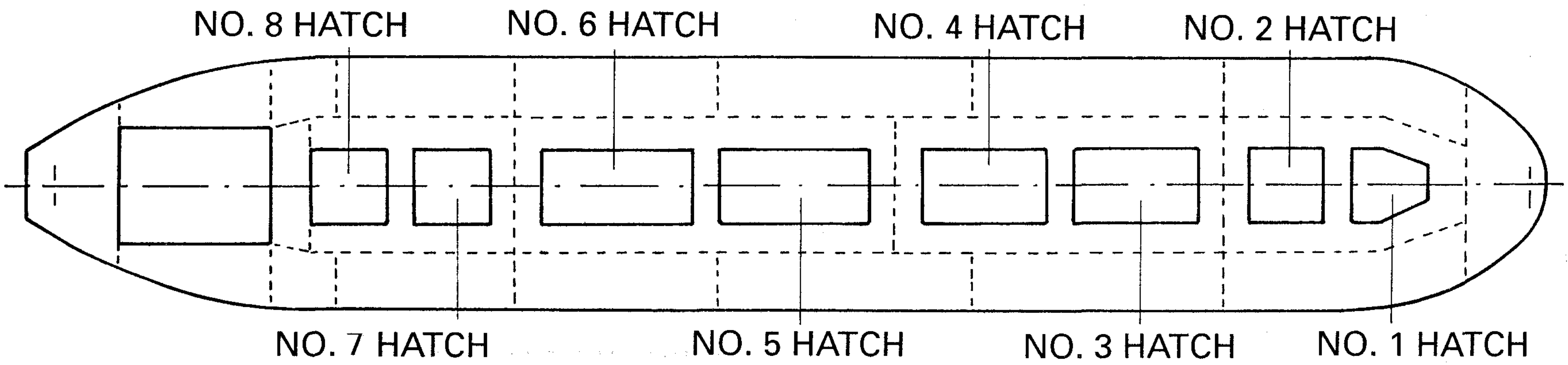


FIG 1.2

IHI Ishikawajima-Harima Heavy Industries Co., Ltd.

REGINA OLDENDORFF - GENERAL ARRANGEMENT PLAN
(reduced to 1/16th its original size)

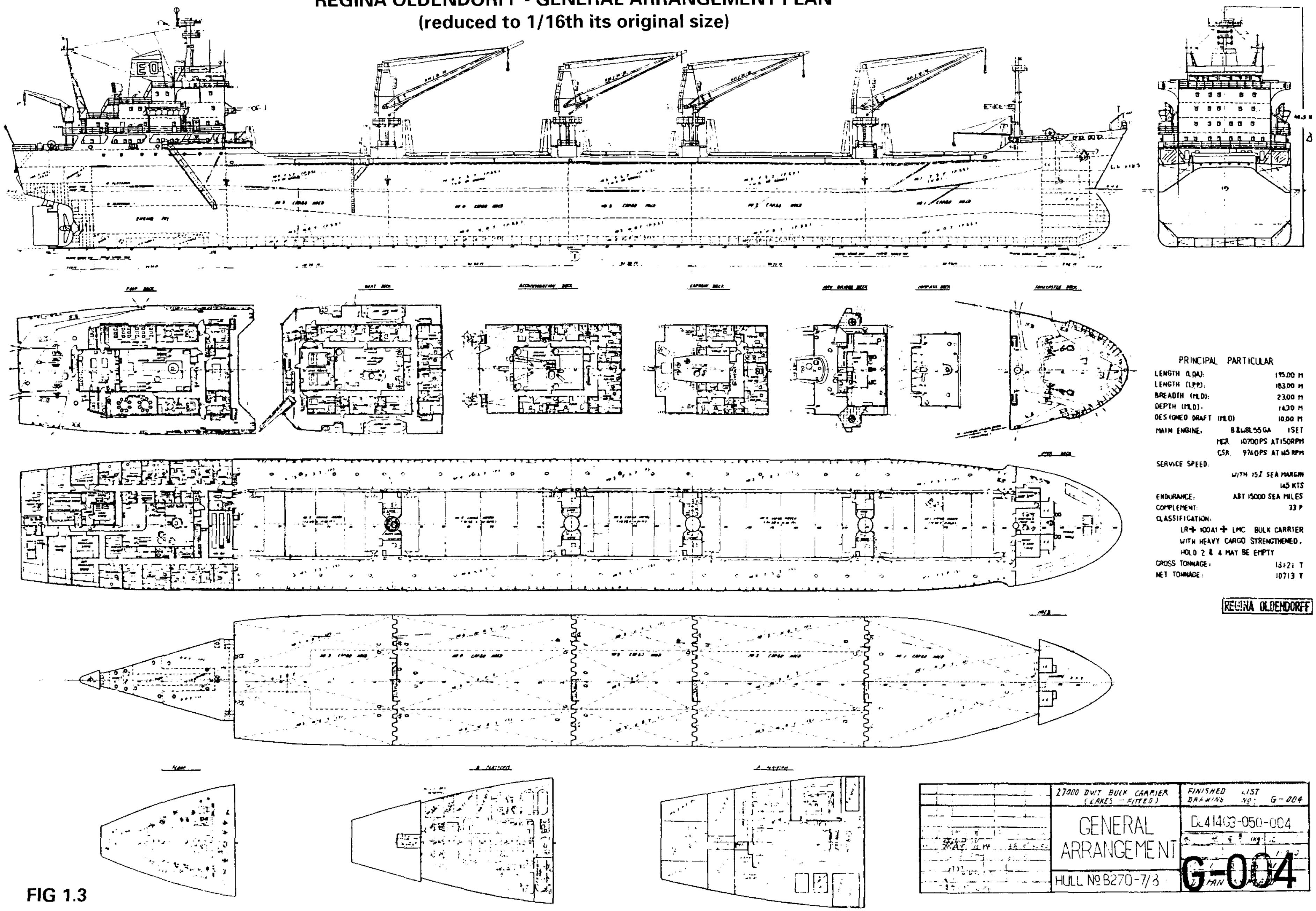
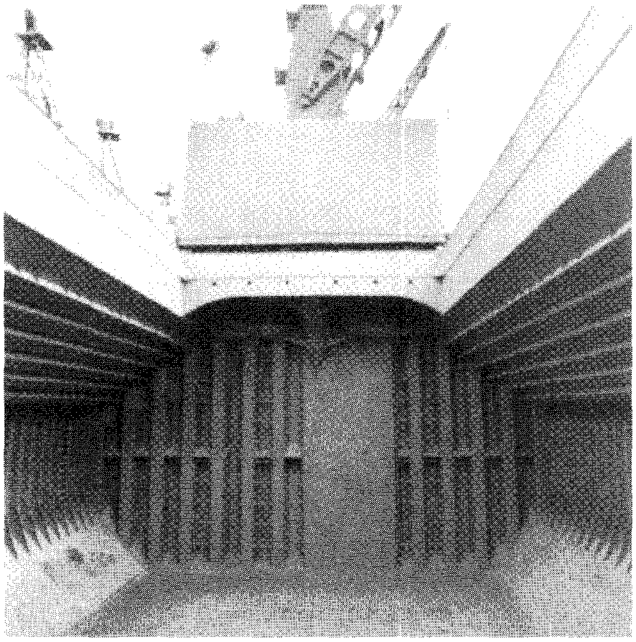
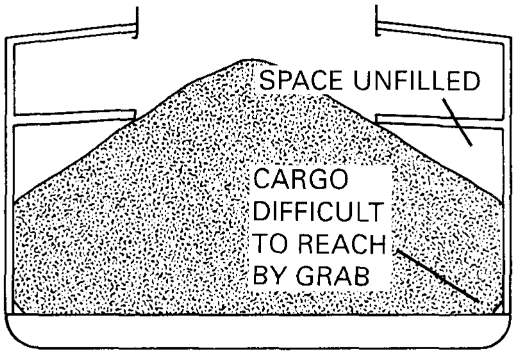


FIG 1.3

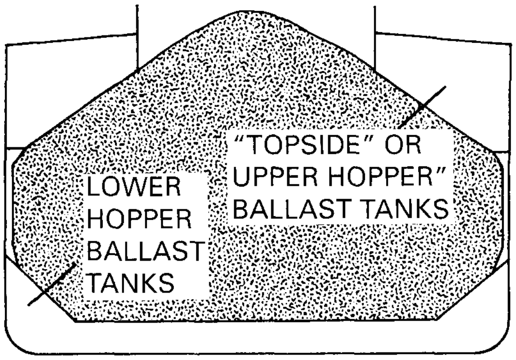
BULK CARRIER HOLD



BULK CARGO LOADED IN A TRADITIONAL TWEENDECK VESSEL: TRIMMING IS REQUIRED AND DISCHARGE IS DIFFICULT



LOW DENSITY BULK CARGO LOADED IN A BULK CARRIER:
LITTLE TRIMMING IS REQUIRED AND ALL THE CARGO IS ACCESSIBLE FOR GRAB DISCHARGE



HIGH DENSITY BULK CARGO LOADED IN A BULK CARRIER:
NO TRIMMING MAY BE REQUIRED, BUT THIS DEPENDS UPON THE PROPERTIES OF THE CARGO.
CARGO IS ACCESSIBLE FOR GRAB DISCHARGE

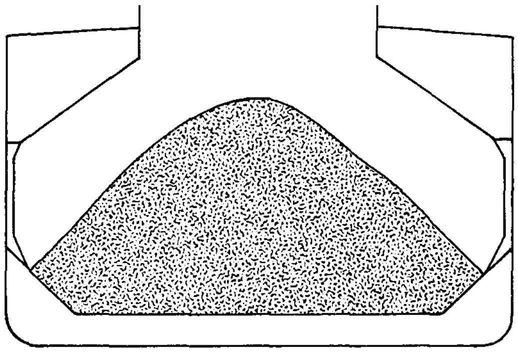


FIG 1.5

Chapter 1

BULK CARRIERS PAST, PRESENT AND FUTURE

Evolution from tramp ships, categories of bulk carrier, the layout of a bulk carrier with particular reference to its distinctive features

BULK CARRIERS, or bulkers, are ships designed primarily for the transportation of solid bulk cargoes. Such cargoes are generally uniform in composition, and are loaded directly into the cargo space without any intermediate form of containment.[22] The range of cargoes carried in bulk carriers is considerable. Leading bulk cargoes in world trade are iron ore, coal, grain, bauxite/alumina and phosphate rock, along with substantial quantities of concentrates, petroleum coke, steel, ores, cement, sugar, quartz, salt, fertilizers, sulphur, scrap, aggregates and forest products.

In 1990 world seaborne trade in iron ore and black coal was in each case about 350 million tonnes, with 190 million tonnes of grain being shipped. Illustrative of minor bulks are cement and sugar, of which more than 20 million tonnes each were carried in 1990.

The bulk carrier evolved from the closed shelter-deck cargo vessel (the 'tramp'), and the ore carrier, in the mid-1950s and thereafter developed rapidly in size and number. Whilst in 1960 only about one-quarter of bulk cargoes were carried in single-deck bulk carriers, the situation was transformed by 1980 at which time almost all bulk cargoes were transported by bulkers. Changes to international rules, such as the 1966 Load Line Convention and the IMO Grain Rules, enabled designers to take advantage of the inherent stability of the bulk carrier, and to develop its self-stowing characteristics. A further evolution in design took place in the 1980s with the conbulk vessel designed to meet the changing pattern of international trade, and to accommodate in particular the growth of containerised cargoes.[23]

Handy-sized bulkers: On 1 January 1990, the world fleet of bulk carriers of 10,000 tonnes deadweight and upwards, excluding bulk carriers trading only on the North American Great Lakes, totalled approximately 5,000 vessels.[20] The most common size of bulk carrier was the handy-sized vessel with a displacement of 25,000-50,000 tonnes and a draft of less than 11.5 metres. There were some 2,000 handy-sized vessels in service in 1990, and a further 1,500 vessels in the 10,000-25,000 tonnes deadweight range which, though smaller than handy-sized vessels, possess the same characteristics and can conveniently be grouped with them.

The handy-sized bulker (Fig. 1.3) is so called because her comparatively modest dimensions permit her to enter a considerable number of ports, worldwide. Such vessels are used in the many trades in which the loading or discharging port imposes a restriction upon the vessel's size, or where the quantity of cargo to be transported requires only a ship able to carry 50,000 tonnes or less.

Handymax bulkers: The trend is for each category of bulker to increase in size, and some commentators now consider the larger handy-sized bulkers, in the 35,000-50,000 tonnes range, to be a separate category, the handymax bulker.

Panamax bulkers: Larger than the handy-sized vessel is the Panamax bulk carrier (Fig. 1.1), so named because she is designed to the maximum dimensions (particularly the maximum breadth) which can pass through the Panama Canal. The limiting dimensions for canal transit are loa 289.5 metres, extreme breadth 32.3 metres and maximum draft 12.04 metres. Some Panamax vessels have summer drafts in excess of the canal limit, so can only pass through the canal partly loaded. The service speed of modern Panamax vessels is typically 14 knots.

In 1990 there were about 800 Panamax vessels of 5,000-80,000 tonnes deadweight. Panamax bulkers are extensively employed in the transport of large volume bulk cargoes such as coal, grain, bauxite and iron ore in the longhaul trades. The fact that most United States ports can accept no ships larger than Panamax size is an important factor in their continued popularity.

Some analysts expect wide-beamed shallow-drafted bulk carriers of up to 100,000 tonnes deadweight to be developed in the 1990s to carry coal more economically between United States and European ports.

Cape-sized bulkers: Cape-sized bulk carriers (Fig 1.33) have deadweights in the range of 100,000-180,000 tonnes deadweight. Whilst most lie within the 100,000-140,000 tonnes bracket, new buildings in recent years have been concentrated in the 140,000-160,000 tonnes range. Cape-sized vessels, with loaded drafts usually in excess of 17 metres, can be accepted fully laden at only a small number of ports worldwide and are engaged in the longhaul iron ore and coal trades. The range of ports which they visit is increased by the use of two port discharges, the ship being only part laden on reaching the second discharge port. Service speeds of modern Cape-sized vessels are typically 12.5-14 knots.

The tendency towards a gradual increase in deadweight of ships which has occurred within this category over time has been noticeable within the handy-sized and Panamax categories, too.

VLBCs: There were about 65 very large bulk carriers (VLBCs) in service in 1990, mainly employed on the Brazil/Europe and the Australia/Japan routes (Fig. 1.40). VLBCs are bulkers greater than 180,000 tonnes deadweight. A number of these largest vessels are special types such as ore carriers, ore/oil carriers and OBOs, classes which are discussed below.

Mini-bulkers: In addition to the 5,000 bulkers grouped into the handy-sized, Panamax, Cape-sized and VLBC categories already described, there are engaged in international trade a considerable number of small bulk carriers of less than 10,000 tonnes deadweight which are employed primarily in the coastal,

FIG 1.6 REGINA OLDENDORFF — STARBOARD WINDLASS

FIG 1.7 REGINA OLDENDORFF — FORECASTLE SPACE, STARBOARD SIDE, LOOKING FORWARD

FIG 1.8 THE REGINA OLDENDORFF ALONGSIDE IN LIVERPOOL

short-sea and middle trades in European waters and other parts of the world, carrying smaller consignments of bulk cargoes to smaller ports. Such vessels are sometimes called mini-bulkers (Fig. 1.35). Some 2,500 mini-bulkers operated in European waters in 1984, though a large proportion of these vessels were equipped and certificated for unrestricted trade, and some do trade worldwide.[17]

Reasons for varied sizes of bulk carriers: Receivers of bulk cargoes have very varied requirements for tonnes delivered per month or per year. The size of vessel that they choose to carry their cargoes and the frequency that such vessels are employed will be influenced by a variety of factors, including the receivers' storage capacity, depth of water in the berth, regularity of the demand for the commodity, and the financing of its purchase. Less frequently the size of vessel chosen will be governed by the limiting size for the loading port. This variety in demand has created a versatile world fleet of very varied ship sizes.

Geared bulk carriers: Many handy-sized and mini-bulkers and a few Panamax vessels are equipped with shipboard cranes or derricks for the loading or discharge of cargo: such vessels are described as geared bulk carriers. Loading or discharging by means of ships' cranes or derricks fitted with grabs is normally a comparatively slow means of cargo handling, most useful in ports which are poorly equipped for handling bulk cargoes.

Self-unloaders: Self-unloaders (Fig. 1.41) are bulk carriers equipped with conveyor belt discharging systems with booms which can be swung out from the ship to discharge directly ashore. Such systems are capable of achieving discharging rates similar to those of shore-based unloading equipment. This equipment is expensive to install and reduces the space available for cargo, but these disadvantages can be outweighed in the short-sea trades by the ability to reduce time spent in port substantially. The numbers and sizes of self-unloaders are increasing, and their role seems likely to continue to grow. In a significant development British Steel, the UK's leading steelmaker, in 1991 introduced two 96,000 tonnes deadweight self unloaders, mv *Western Bridge* and mv *Eastern Bridge,* to serve its Port Talbot terminal.

Ore carriers: In 1990 ore carriers (Fig. 1.2) constituted about 10 per cent of Cape-sized bulkers. They are single-deck vessels designed specifically for the carriage of iron and other heavy ores. They are characterised by small holds with high centres of gravity. Few ore carriers have been built in recent years, but those few have been amongst the largest bulk carriers afloat, and include the *Berg Stahl,* 359,006 tonnes deadweight which was, in 1990, the largest bulker in service.

Ore/bulk/oil carriers: Ore/bulk/oil (Fig. 1.36) carriers are designed with dual-purpose holds which can be used for the carriage of both dry and liquid bulk commodities. Most vessels of this type are also strengthened for the carriage of ore and are referred to as OBOs. Most OBOs are Panamax or Cape-sized.

Ore/oil carriers: Ore/oil carriers (Fig. 1.37) have centre and side compartments. When carrying oil both centre and side compartments can be used, whilst only the centre compartments are used when carrying ore.

Combination carriers: Ore/oil carriers and OBOs, known collectively as combination carriers, were developed to allow the vessel to trade in either the bulk carrier or tanker trades, according to seasonal or commercial demand, and to allow the proportion of time spent in non-revenue-earning ballast legs to be minimised. In the 1980s there was a steady decline in the combination carrier fleet which by 1989 had shrunk to 17 per cent (by total deadweight) of the bulk carrier fleet from a high point in 1975 of 43 per cent.

In practice it has not been found easy to switch ships between oil and bulk cargoes on a voyage-to-voyage basis because of the effort required to clean holds to an acceptable standard after carrying oil, and the difficulty in matching discharge and loading ports without long ballast hauls. The declining popularity of combination carriers was probably hastened by their higher capital cost, and the fact that they have been prone, statistically at least, to the types of accidents experienced by both tankers and bulk carriers.[23]

Open bulk carriers: Open bulk carriers (Fig. 1.38) are designed for the carriage of packaged lumber and units of woodpulp. Such cargoes are best carried in rectangular cargo holds with an open hatch layout in which hopper tanks are replaced by straight hold sides, and the entire hold is open to the sky when the hatch covers have been opened; these are features of the type. Open bulk carriers are usually geared, some being fitted with fixed cranes whilst others are provided with travelling gantry cranes.

Conbulkers: Bulkers fitted out for the carriage of containers were developed from open bulk carriers when it was realised that this type of bulker was well suited for container carrying when circumstances were right (Fig. 1.39). The necessary modifications consisted of suitable strengthening of tanktop and hatchcovers, and provision of container securing sockets. The shipboard cranes fitted to conbulkers are of a capacity appropriate for containers, and service speed is likely to be 14 or even 16 knots-higher than typical bulker speeds, as appropriate for the carriage of higher value commodities. Conbulkers are able to carry a wide range of bulk cargoes as well as timber and containers.[23]

The characteristics and operation of some of the foregoing categories of vessel are described in Chapter 18.

Typical bulk carrier general arrangements

What are the characteristics of a bulk carrier? In order to obtain a good deadweight carrying capacity such ships are given a full form. Many of them are very large to take advantage of economies of scale, and they usually have wide hatches and clear holds to facilitate loading and discharging. A good example of a versatile handy-sized bulker is the *Regina Oldendorff,* illustrated in Fig. 1.3 and Photo. 1.8. She possesses most of the features found in modern bulk carriers, and has been used extensively as a model in this book.

The *Regina Oldendorffis* a 28,000 deadweight geared bulk carrier with a length of 195 metres, breadth of 23 metres, depth of 14.3 metres and summer draft of 10.22 metres. Precise dimensions and details of tank capacities, are appended at Appendix 1.4. (see

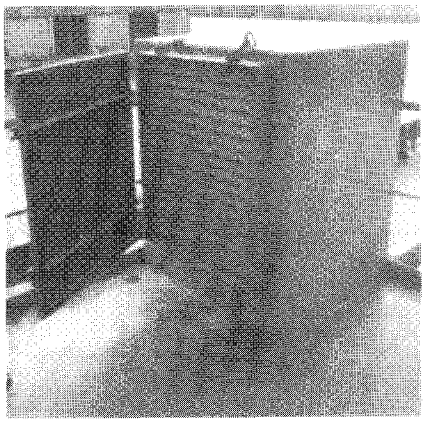


FIG 1.9. HOLD VENT INLET

FIG 1.10. MAIN DECK

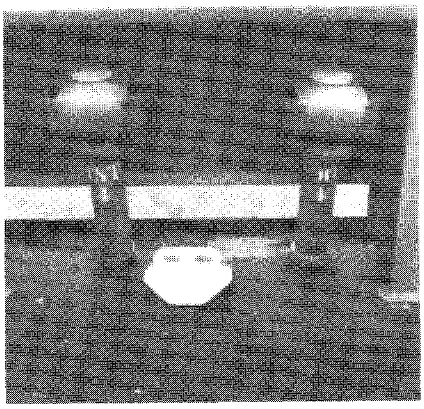


FIG 1.11. AIRPIPES FOR NO.4 STBD TOPSIDE & STBD WB TANKS

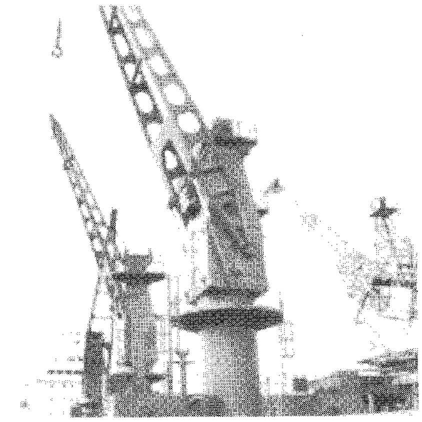


FIG 1.12. MASTHOUSE SURROUNDING CRANE PEDESTAL

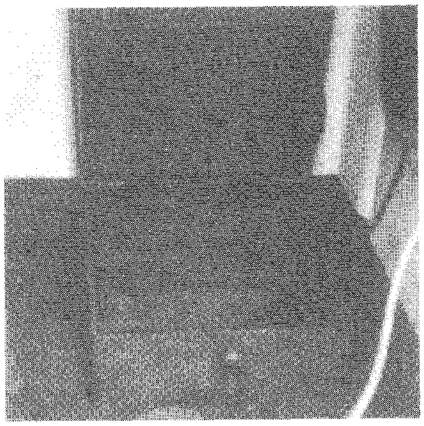


FIG 1.13. HOLD ACCESS IN MASTHOUSE

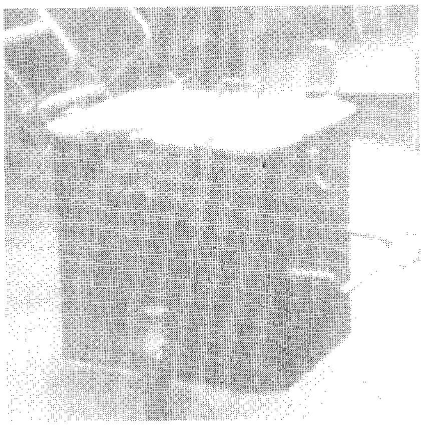


FIG 1.14. HOLD ACCESS ON OPEN DECK

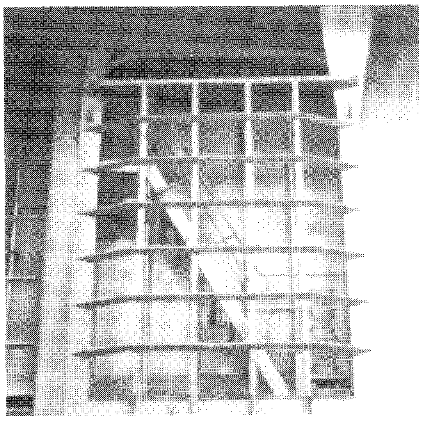


FIG 1.15. 'AUSTRALIAN' HOLD LADDER

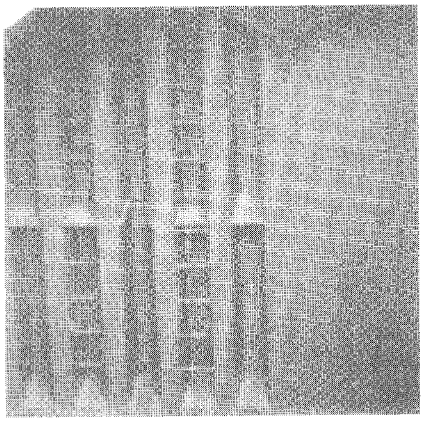


FIG 1.16. VERTICAL HOLD LADDER

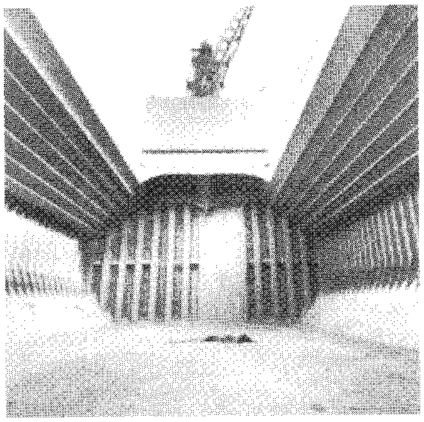


FIG 1.17. CORRUGATED TRANSVERSE BULKHEAD & TANKTOP

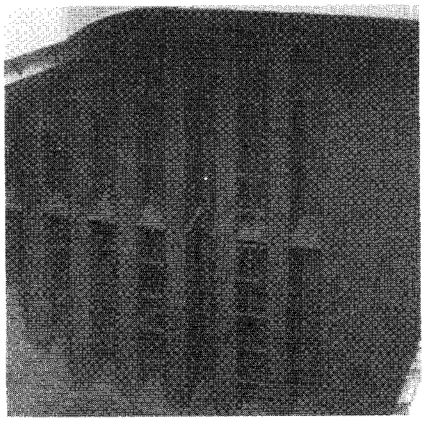


FIG 1.18. SHEDDER PLATE

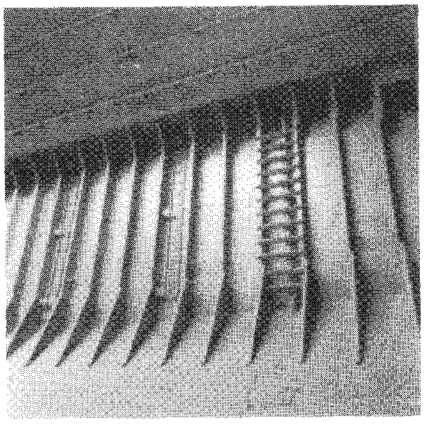


FIG 1.19. LOWER HOPPER SIDE AND SHELL

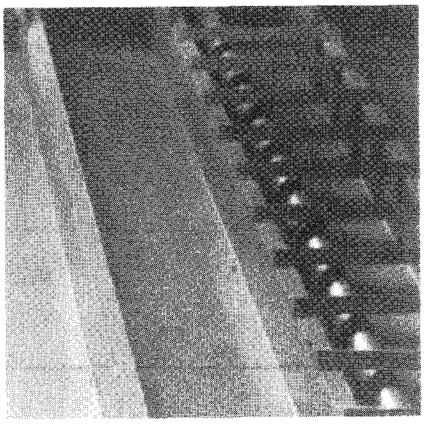


FIG 1.20. AIRPIPES IN HOLD

FIG 1.21. SOUNDING PIPES IN HOLD

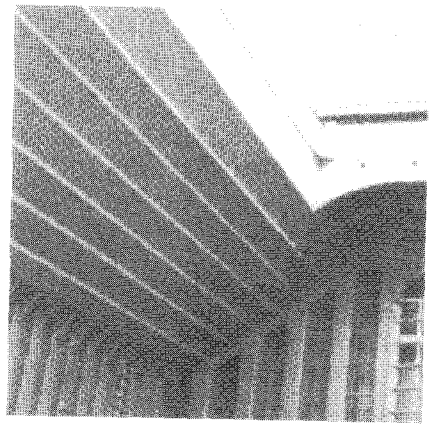


FIG 1.22. UPPER HOPPER TANK SIDES

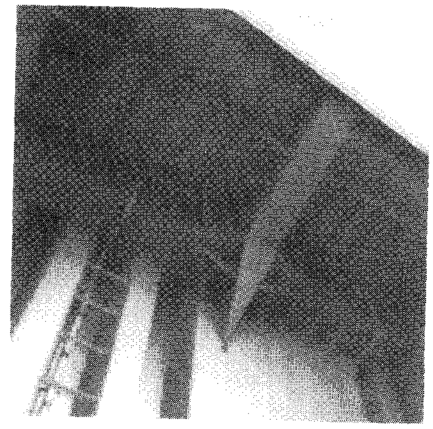


FIG 1.23. HOLD DECKHEAD

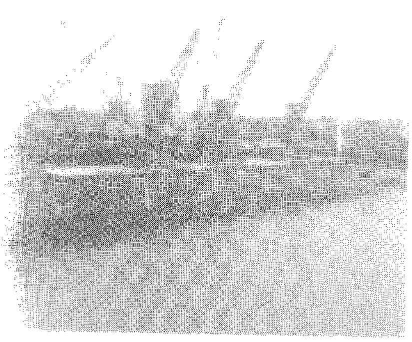


FIG 1.24. POSITION OF CRANES

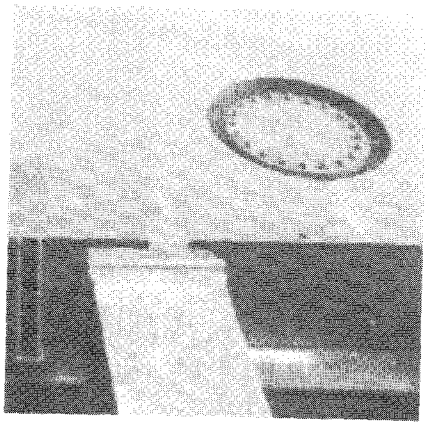


FIG 1.25. CEMENT LOADING PORT IN HATCH LID

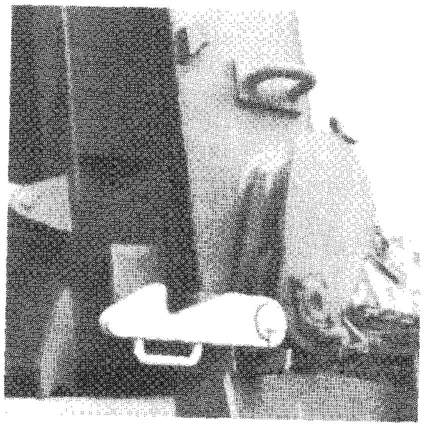


FIG 1.26. HATCH RETAINING SAFETY LATCHES

FIG 1.27. NAVIGATING BRIDGE

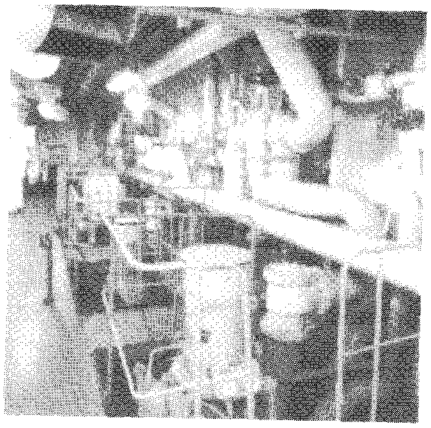


FIG 1.28. BALLAST CONTROL AREA

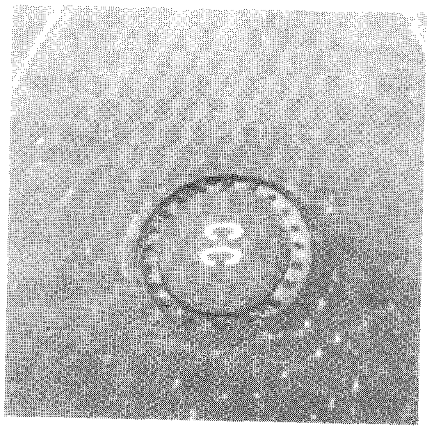


FIG 1.29. TOPSIDE TANK MANHOLE

FIG 1.30. FITTINGS FOR TIMBER STANCHIONS

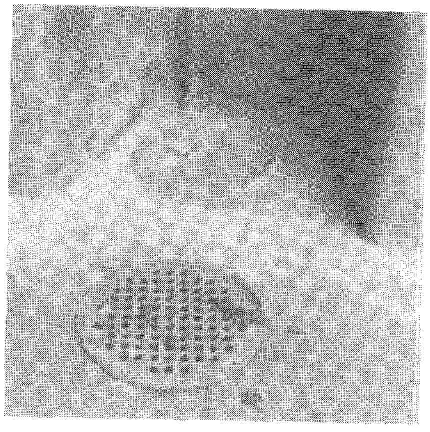


FIG 1.31. HOLD BILGE WELL WITH FLUSH REINFORCED COVER

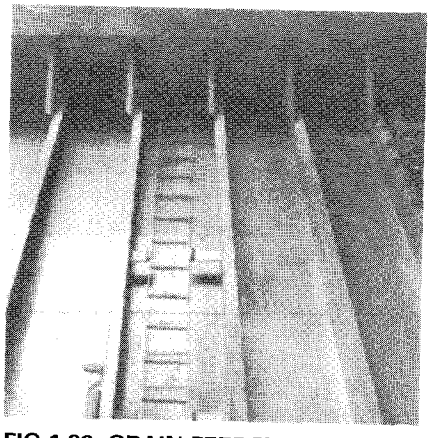
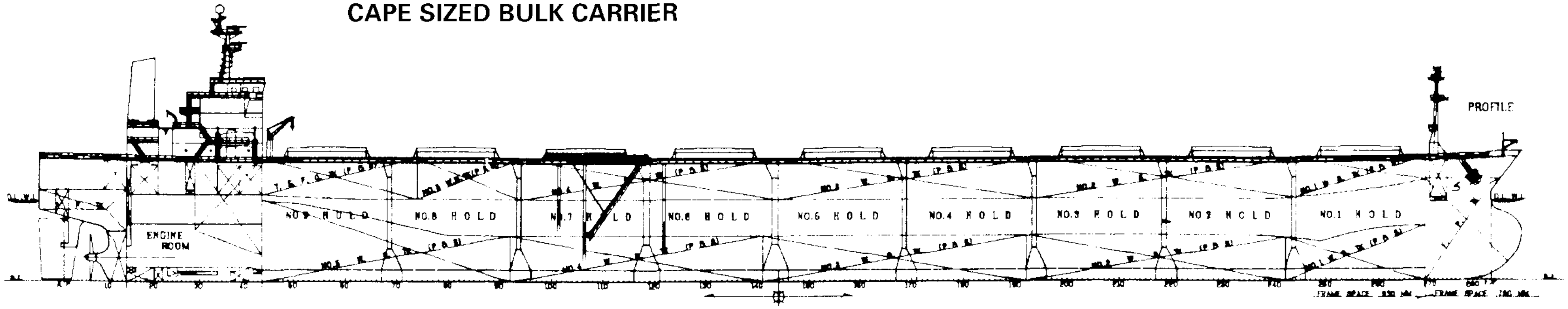
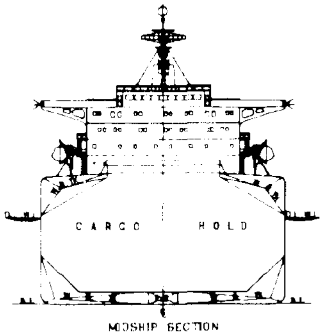


FIG 1.32. GRAIN FEEDER PORTS IN TOPSIDE TANKS

CAPE SIZED BULK CARRIER





Principal Dimensions

Length Overall	266.0	metres
Breadth Moulded	40.5	metres
Depth Moulded	21.2	metres
Summer Draft	14.5	metres
Deadweight on Summer Draft	115.000	tonnes
Service Speed	14.0	knots

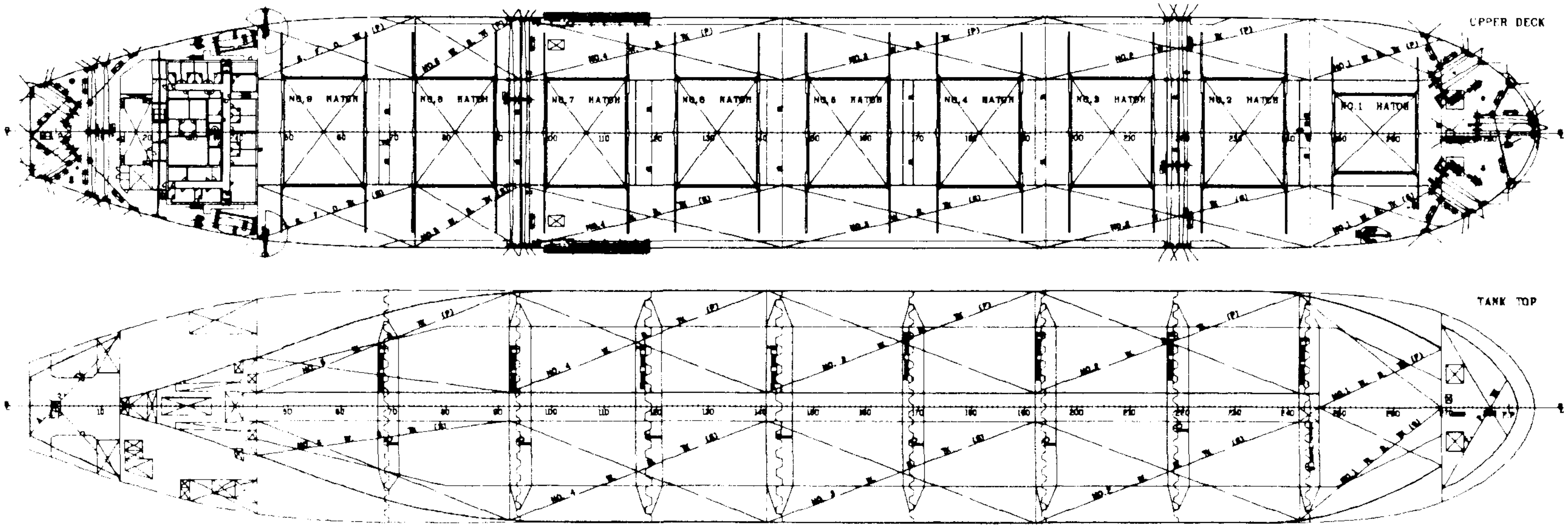


FIG 1.33

page 304). She was built by Dalian Shipyard of China and delivered in May 1986. Classed +100A1 by Lloyd's Register of Shipping, she is strengthened for heavy cargoes. She was constructed and equipped for the carriage of grain, timber, ore, steel products, coal, hot rolled steel coils, scrap and heavy cargoes, and is 'Lakes fitted' which means that she is properly equipped to pass from the Gulf of St Lawrence through the Welland Canal to the North American Great Lakes.

The machinery spaces of the *Regina Oldendorff* are situated aft, the accommodation block is located over the machinery spaces and the navigating bridge is also aft, above the accommodation. The ship's main body containing the holds is single-decked-in other words, there are no horizontal subdivisions in the holds. The holds are closed with steel mechanical hatch covers. In all the foregoing respects the *Regina Oldendorff* is representative of almost all bulk carriers.

Other characteristics of bulk carriers vary according to design and trade. The *Regina Oldendorff* has five cargo holds, a typical number for a handy-sized vessel, but the number of holds can vary from as many as 11 in a very large bulker, to as few as one in a mini-bulker. The *Regina Oldendorff* is provided with ballast tanks in the double bottoms and lower hopper spaces beneath and beside the holds. More ballast can be carried in the topside, or upper hopper, tanks above the holds, and in the forepeak and afterpeak tanks, at the ends of the vessel. Many bulk carriers are also able to carry water ballast in a hold situated near the midlength of the vessel, but the *Regina Oldendorff* does not have this feature.

The hull form shown in Fig. 1.3. is of a well deck vessel with raised forecastle and poop and with a raked stem with teardrop bulbous bow, and a transom stern. The vessel is propelled by a B&W eight-cylinder diesel engine of 10,700 bhp. Service speed is 14.5 knots and endurance on full bunkers about 15,000 nautical miles.

The vessel's daily consumption of diesel oil is 2.5 tonnes and her fuel consumption, in tonnes per day (tpd), is:

	Speed (knots)	**Loaded**	**In ballast**
Service speed	14.5	31.0	26.0
Economical speed	12.5	20.0	17.5

The shapes of the holds of the *Regina Oldendorff* 'are typical of bulker holds (Fig. 1.5). The sloping sides of the lower hopper tanks keep cargo in the centre of the ship, beneath the hatch openings, from where it can be more easily discharged. The upper hopper tanks occupy the space into which bulk cargo would never flow, and remove the need for trimming of the cargo. This feature is particularly valuable in the grain trades, as it ensures that the vessel can comply with the grain regulations without the need for trimming or for shifting boards. The inclusion of upper and lower hopper tanks improves the handling of bulk cargoes and thereby reduces the overall cost of transportation. It also extends the range of positive stability options which are open to the master. Whilst this hold configuration is by far the most common in bulk carriers, open bulkers, designed for the carriage of packaged lumber and/or containers, have holds with vertical sides (Fig. 1.39).

A bulk carrier's mechanical steel hatch covers are another area in which considerable variety is possible. The steel panels may roll to the hatch side or to the hatch end, they may hinge and fold to the hatch ends, they may lift and roll in piggy-back fashion or they may roll up like a blind. The *Regina Oldendorff* is, provided with folding covers (Fig. 1.34).

The hatch openings of a conventional bulk carrier usually extend for the maximum distance in the fore and aft direction for optimum access to the hold, with minimum space between holds provided for essentials such as masts, crane pedestals, ventilators and hatch cover stowage where required. In the athwartship direction the hatch opening will normally occupy about 50 per cent of the ship's breadth, but special types may provide exceptions to this rule.

In open type bulkers the hatches may occupy as much as 90 per cent of the ship's breadth, with this effect sometimes being achieved by installing twin hatch openings, side by side. Combination carriers which can carry dry bulk cargoes, or oil, will have smaller hatches extending across about 35 per cent of the vessel's breadth.

Many bulk carriers, particularly large ones, are gearless. Geared bulkers may be fitted with swinging derricks, travelling gantry cranes, fixed cranes or boom-mounted conveyor for self-unloading. The *Regina Oldendorff* "is equipped with four fixed cranes of 25 tonne safe working load (SWL). Their positions between the hatches (Fig. 1.24) mean that they can serve all five holds.

Aboard bulkers fresh water is used for domestic purposes such as drinking, washing and cooking. The sanitary (i.e., toilet flushing) system uses fresh water on some ships and salt water on others. A fresh water system suffers less from corrosion, but requires the ship to provide more fresh water. Fresh water is used to fill the jackets which cool the main and auxiliary machinery and which are themselves cooled with sea water.

A mini-bulker will require some 5-10 tonnes per day of fresh water, whilst a Cape-sized vessel will routinely use 20 tpd. Modern bulkers are normally provided with a fresh water generator, which manufactures fresh water from sea water. Such a machine is likely to be powered by waste heat from the main engine and will generate all the water the vessel requires, so long as the engine is running at full service speed. Fresh water shortages may occur when a vessel is required to spend a long time at anchor with the main engine shut down, when she is operating at reduced (economic) speed and producing little waste heat, or when she is operating in coastal waters which may be polluted, and where it may be inadvisable to generate fresh water.

Typical bulk carrier details of arrangements

When considering the manner in which a bulk carrier is likely to be designed and equipped it is useful to refer again to the plans of the *Regina Oldendorff* (Fig. 1.3) and to her photograph (Fig. 1.8), as it is this vessel which is described in the following pages.

Forecastle deck: The forecastle deck is provided

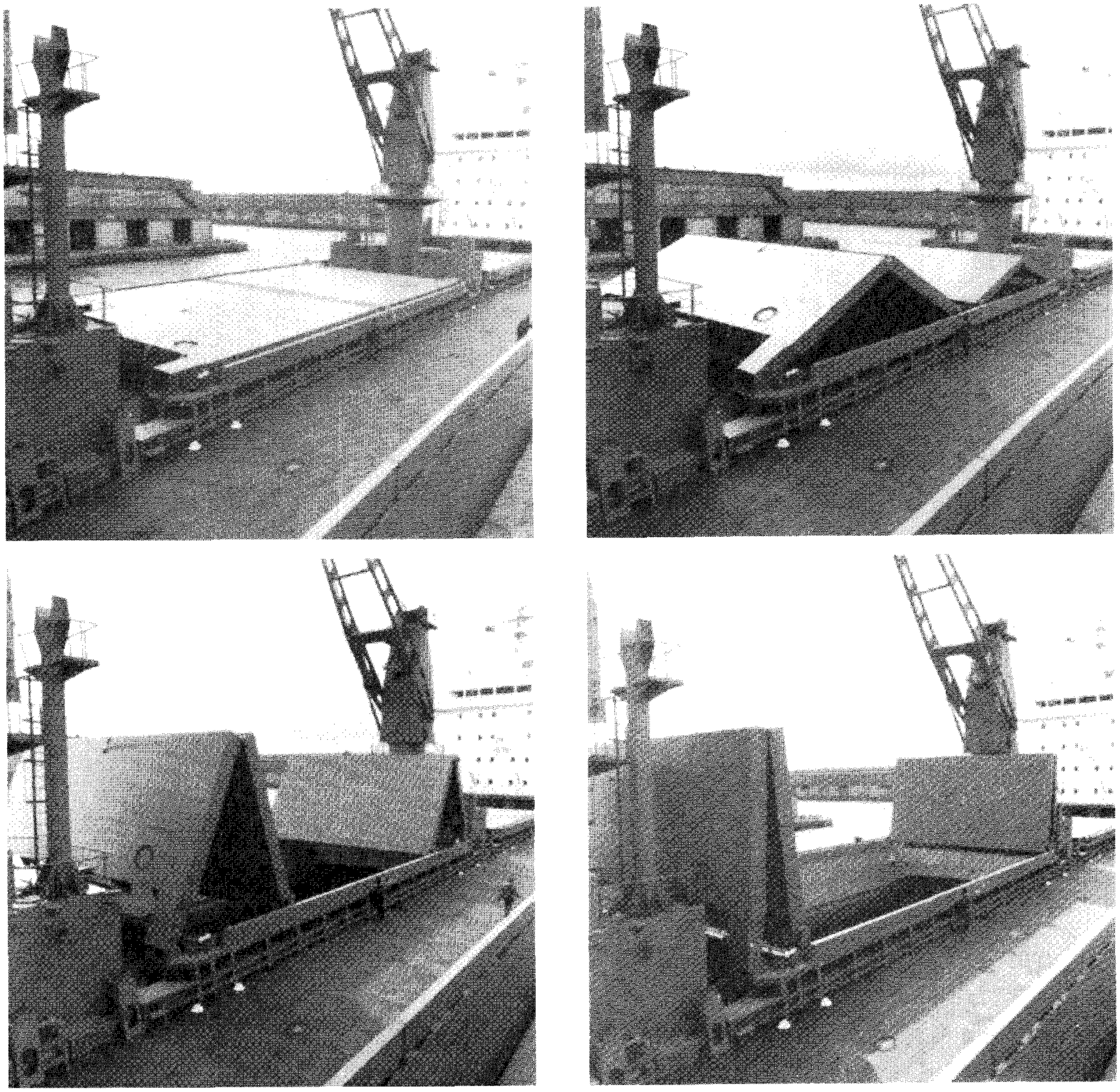


FIG 1.34. FOLDING HATCH COVERS OPENING

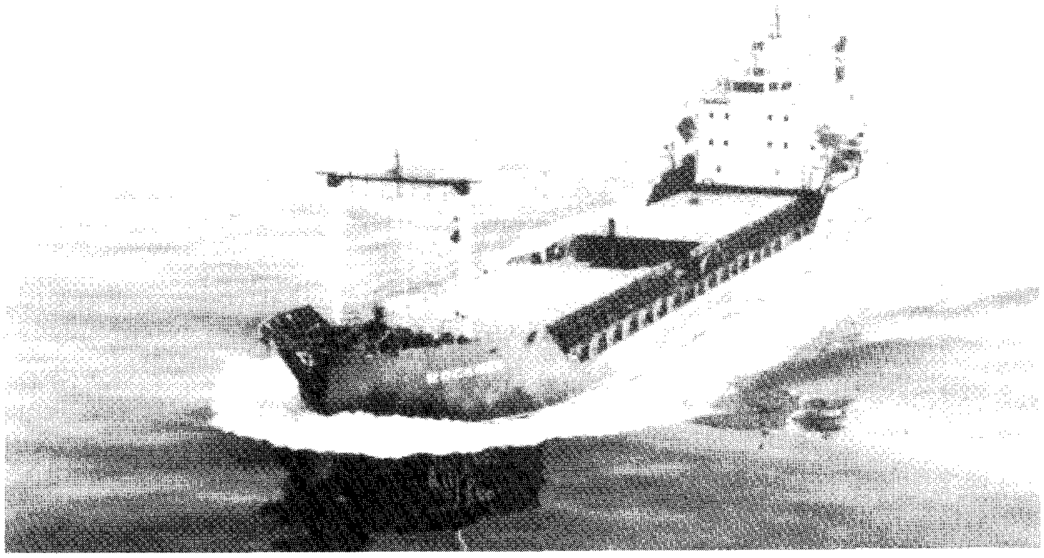


FIG 1.35. 6,000-DWT MINI-BULKER ROCKNES
(SKYPHOTOS)

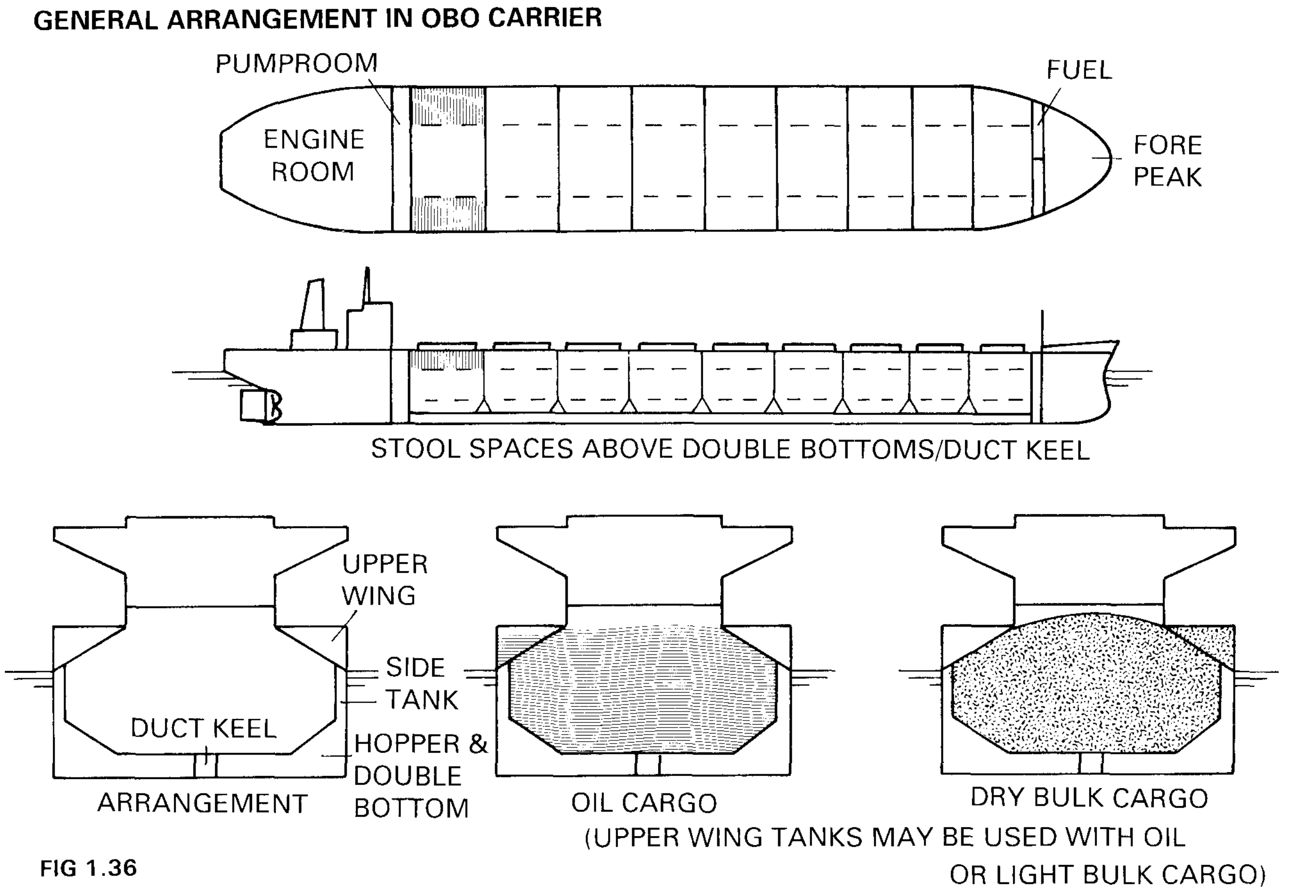


FIG 1.36

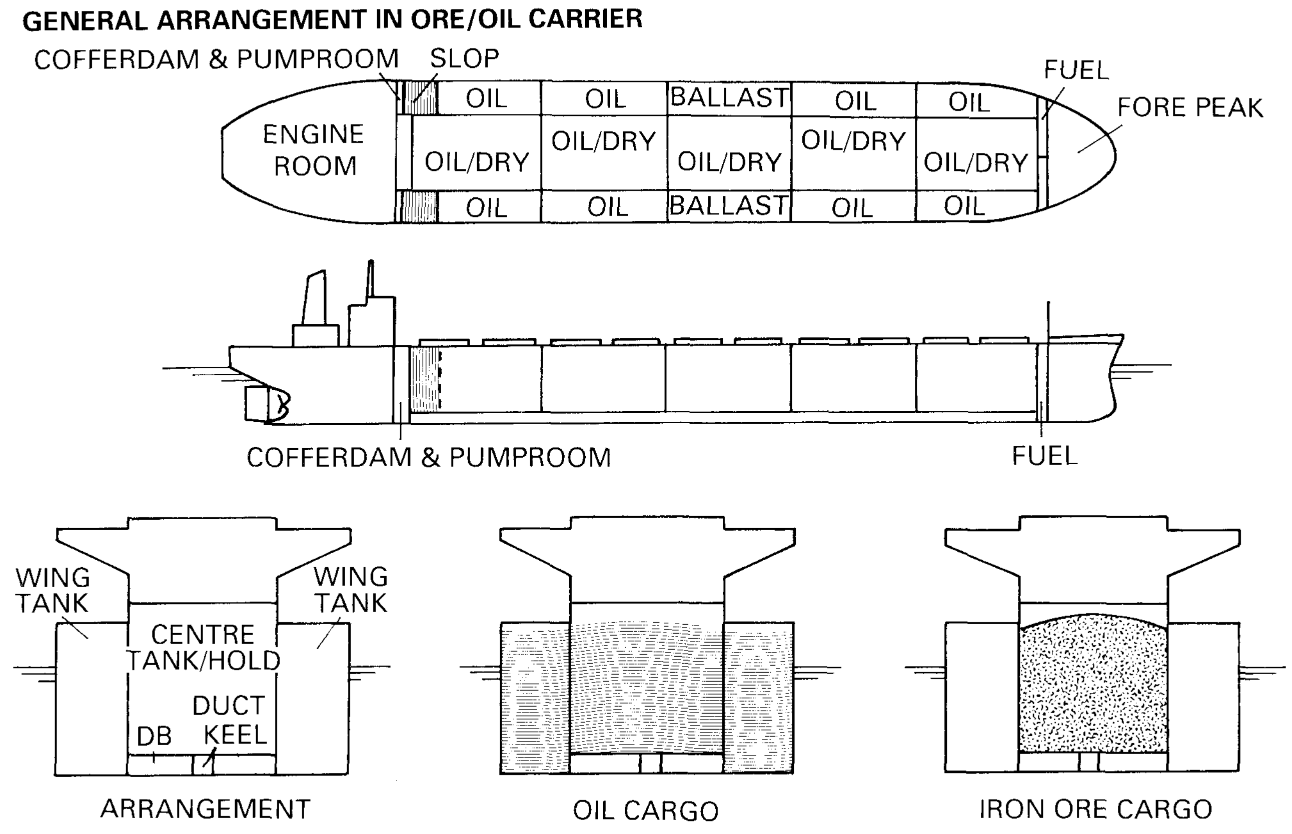
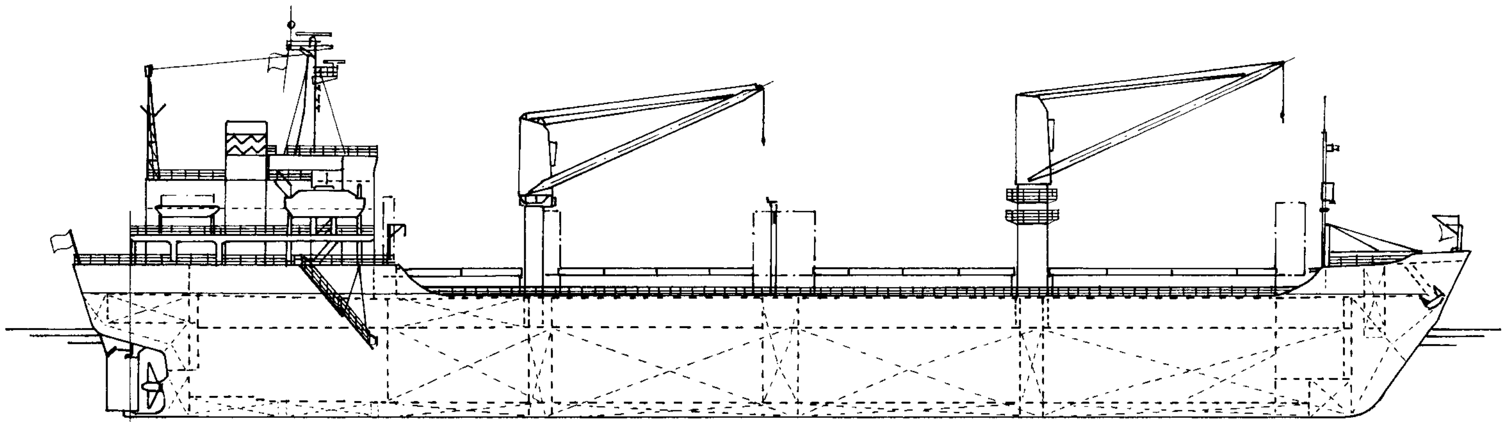
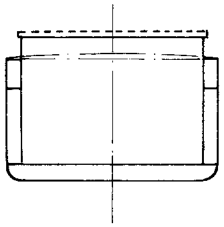


FIG 1.37

OPEN BULK CARRIER FOR FOREST PRODUCTS





Principal Dimensions

Length Overall	134.5	metres
Breadth Moulded	20.5	metres
Depth Moulded	11.5	metres
Summer Draft	8.7	metres
Deadweight on Summer Draft	12,275	tonnes
Service Speed	14.4	knots

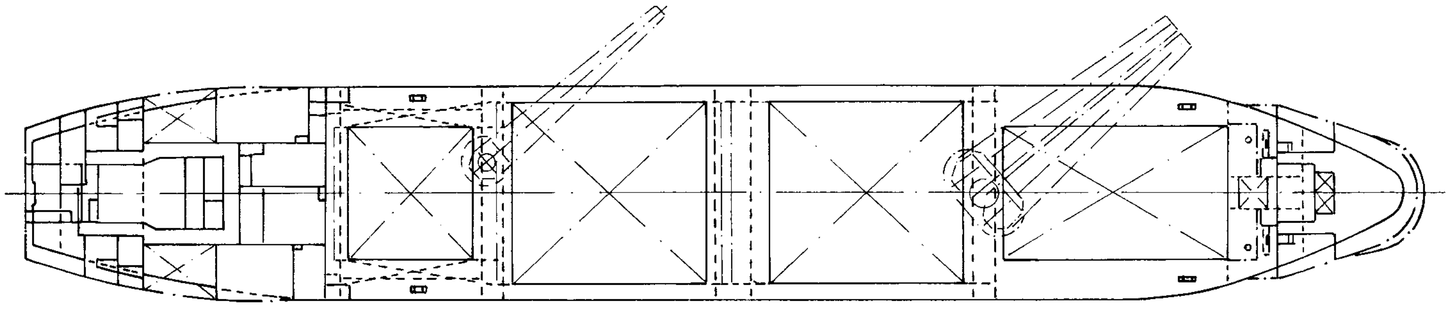


FIG 1.38

with port and starboard windlasses for heaving in, paying out and holding on to the anchor cables (Fig. 1.6). Also provided are port and starboard powered rope reels, with drum or warping ends for handling additional ropes. Gearing between the different units on the forecastle deck permits a motor situated in the forecastle space to drive the starboard windlass, starboard powered reel and starboard drum end simultaneously or independently, and similar arrangements are provided for the units on the port side. The motors on many ships can be linked to provide double power to one side if required, or for operating the opposite side in the event of equipment failure. The mooring winches, particularly on larger bulk carriers, are likely to be provided with a self tensioning facility.

With the exception of mooring ropes or wires which are stowed permanently on the powered rope reels, all mooring ropes and wires will be passed down through the access hatch into the forecastle store for the sea passage, and only brought back on deck in the approaches to the next port. Those ropes remaining on the reels should be covered with canvas to protect them from sunlight and spray. Sounding pipe caps for the forepeak, the echo-sounder compartment and the chain locker soundings are sited on the forecastle deck.

Forecastle space: This space (Fig. 1.7) beneath the forecastle deck provides shelter for the windlass motors and also houses the motors for the hatch cover hydraulics, where such are fitted. There is space for the storage of mooring ropes, and for a heavy towing wire on a reel. The hawse pipes and spurling pipes pass through the forecastle space. Access to the forepeak ballast tank is by a manhole in the deck of the forecastle space, and to the port and starboard chain lockers by doors in the sides of the chain lockers, which extend from the forecastle space down into the forepeak tank.

A common arrangement which is found aboard the *Regina Oldendorff* is an eductor system powered by water from the fire extinguishing/washdeck line, with its control valves in the forecastle space. This is used to pump out the forecastle space bilges and the chain locker bilges. Water from the washdeck line for washing mud from the anchor cables is piped through the forecastle space to the hawse pipes. It is normal for the forecastle space bilges to be provided with high level alarms, activated by float switches in the bilges, so that the officer of the watch on the bridge will receive prompt warning of any flooding of the forecastle space.

On the *Regina Oldendorff* the forecastle space contains the normal valve wheel and extended spindle for the direct manual closing of the forepeak ballast line, thereby ensuring the watertight integrity of the collision bulkhead between forepeak and No. 1 hold. On larger bulkers paint will be stored in a paint locker set into the forecastle space but with a separate entrance to reduce the spread of any explosive vapours from the paint, and a carpenter's shop may be provided.

Forepeak tank: A forepeak tank can have a capacity of anything from 200 tonnes or less up to 9,000 tonnes or more, depending upon the size of ship. The space within the forepeak tank will be broken up by the horizontal stringer plates, and the vertical web frames, floors and wash bulkheads which reinforce the shell plating. These structural members are provided with lightening holes which reduce the weight of steelwork, and with drain holes that permit the flow of water necessary for the filling and emptying of the compartment.

The bulbous bow may form part of the forepeak tank, or may be separated from it and maintained as a sealed void space, accessible only through a manhole in the forepeak, although the former is more common. Like all ballast tanks the forepeak is provided with a ballast (pipe) line for filling and emptying the compartment and with a forepeak valve set in the line to control the process. This valve will probably be remotely controlled, and will be duplicated by the manual valve already described.

The echo-sounder sensor of the *Regina Oldendorff* is located in a separate watertight compartment at the base of the forepeak tank, accessible from the forepeak through a manhole, and this is a normal arrangement. A second echo-sounder sensor may be provided somewhere near the stern of the ship, provision for switching between forward and aft being provided on the bridge.

Upper deck: The upper, or main, deck of the *Regina Oldendorff* extends, continuously over the length of the ship from forecastle space to within the poop accommodation. As an open deck it extends from the break of the forecastle to the bridge front, and includes the surrounds to all the cargo hatch coamings. (Fig.1.10.)

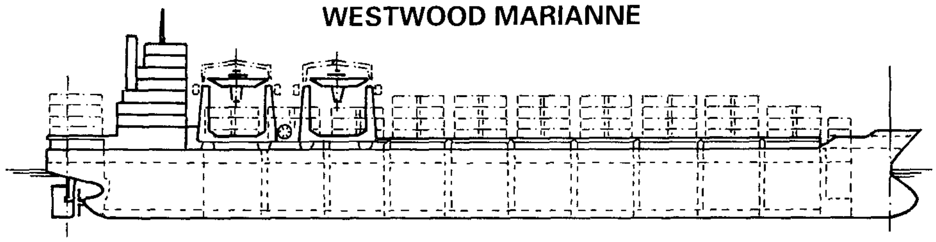
Set into the upper deck are the covered manholes which provide access to the topside, or upper hopper, ballast tanks (Fig. 1.29). Also set into the deck are the sounding pipe caps for the hold bilges and the ballast tanks. Ballast and fuel tank airpipes (Fig. 1.11) are to be found in protected positions against bulwarks, coamings, and masthouses. Ships likely to carry coal cargoes are fitted with pipes down which thermometers can be lowered for taking the temperature within the cargo. Sockets and lugs for the vertical stanchions used with timber deck cargoes are located at the ship's bulwarks (Fig. 1.30).

A masthouse (Fig. 1.12) is to be found positioned over each transverse hold bulkhead, in the space surrounding the crane pedestal. Masthouses provide space for hold ventilation trunks and fans, for hold access hatches, for hydraulic pumps for hatch operation, and for storage and workshops. On the *Regina Oldendorff* the hold ventilator inlets (Fig. 1.9) are located on the masthouses. They are fitted with watertight doors, and face aft.

Cargo holds: These are entered through watertight access hatches (Fig. 1.13) usually located within masthouses or superstructures when such are fitted, as is usual on handy-sized vessels. On larger bulkers the access hatches are likely to be placed on the open deck, between adjacent hatches, since these vessels normally have no masts and no masthouses (Fig. 1.14). It is normal to find an access hatch and ladder at each end of each hold, symmetrically arranged so that, for example, all the forward ladders are to port of the centreline, and all the after ladders are to starboard.

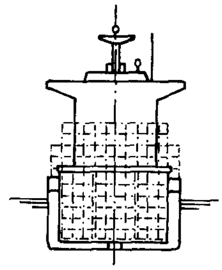
Australian regulations require sloping steel ladders with an intermediate 'resting' platform when the

45,000 TDW TYPE OPEN HATCH BULK CARRIER WESTWOOD MARIANNE



PRINCIPAL DIMENSIONS

DNV+1A1, +MV, BULK/CONTAINER CARRIER, EO
LENGTH (O.A.)/LENGTH (B.P.) 199.90 M/188.70 M
BREADTH (MLD) 30.50 M
DEPTH (MLD) 16.20 M
DRAUGHT (EXT) DESIGN/SCANTLING 10.521 M/11.718 M
DEADWEIGHT AT DESIGNED DRAUGHT 38.866 METRIC TONS
AT SCANTLING DRAUGHT 45.252 METRIC TONS



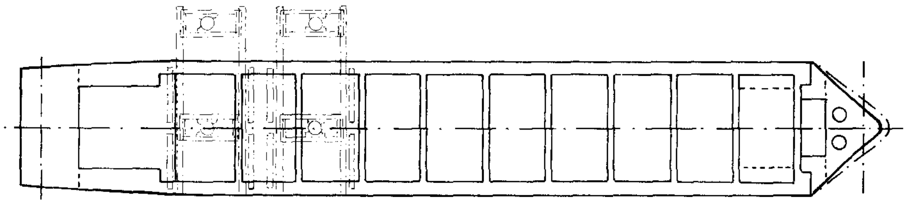
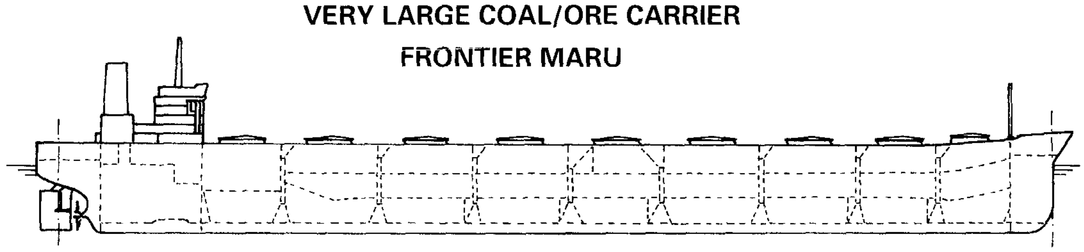


FIG 1.39

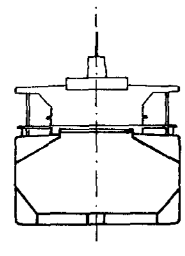
REPRODUCED BY COURTESY OF ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO., LTD

VERY LARGE COAL/ORE CARRIER FRONTIER MARU



PRINCIPAL DIMENSIONS

LENGTH (O.A.)/LENGTH (B.P.)	312.00 M/299.00 M
BREADTH (MLD)	50.00 M
DEPTH (MLD)	26.65 M
ASSIGNED DRAUGHT (EXTREME)	19.881 M
DEADWEIGHT	224,222 METRIC TONS
GROSS TONNAGE	112,436.4 T



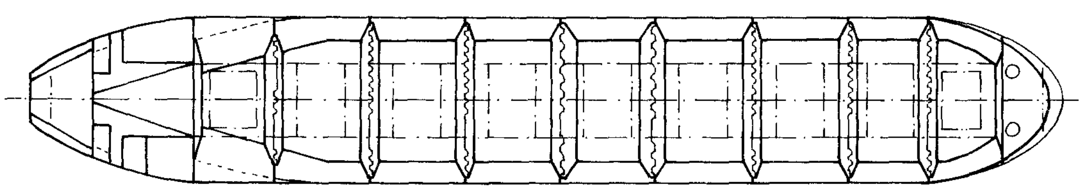


FIG 1.40

REPRODUCED BY COURTESY OF ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO., LTD height is greater than 6 metres, so each hold in larger bulk carriers trading worldwide is provided with at least one ladder which complies with the regulations, and this feature is provided aboard the *Regina Oldendorff* (Fig. 1.15).

Vertical ladders, fitted as second hold ladders aboard some vessels such as the *Regina Oldendorff (Fig.* 1.16), are sometimes provided with hoops at intervals, as required by some authorities. These allow those using the ladder to pause and lean back against the hoops. However, such hoops are easily damaged by grabs during the discharge of cargo.

The watertight bulkheads at the ends of each hold are usually constructed of vertically corrugated steel work (Fig. 1.17) with a pitch of about 1.5 metres, as can be seen in the general arrangement plan of the *Regina Oldendorff.* This is a simple method of providing the necessary strength and rigidity in a form which does not interfere with efficient loading and discharge, and without the need for additional steelwork. Such corrugated bulkheads are often stiffened horizontally with shedder plates (Fig. 1.18). These plates slope down at 45° to the horizontal so that cargo flows off them during discharge.

The hold tanktop (Fig. 1.17) is designed to present a completely flush surface for mechanical cargo discharging operations. Manholes giving access to the double-bottom tanks are provided with flush-fitting covers, as are the hold bilge wells. The tanktop plating of most bulk carriers becomes dished and indented as the result of cargo loading and discharging activities.

The two bilge wells in each hold are situated in the normal positions close to the after bulkhead in the port and starboard corners of the hold (Fig. 1.31). Each well is closed with a perforated plate. The lower hopper tank sides, featureless expanses of steel plating, slope up from the tanktop to the ship's sides. The shell plating of the ship's sides is supported by vertical framing (Fig. 1.19).

Airpipes (Fig. 1.20) and sounding pipes (Fig. 1.21) which run down the ship's side and the end bulkheads are protected with a heavy steel casing, or with an open webbing of heavy steel bar. The latter, as found aboard the *Regina Oldendorff* and shown in the photographs, is preferable, as cargo can lodge behind casings, making hold cleaning difficult, especially for grain cargoes, when the highest standards of cleanliness are required. All ancillary steelwork, such as brackets, stiffeners, etc., should present no flat surfaces, but should slope down 45 degrees from the horizontal so that cargo flows off during discharge, thus ensuring that no remnants are left behind to present difficulties for subsequent cleaning.

The sides of the upper hopper or topside tanks, like the lower ones, are usually featureless expanses of steel plating which slope upwards from the ship's side to the hatch coaming. The *Regina Oldendorff is* unusual in that the longitudinal framing of the upper hopper tank sides is in the hold instead of in the,tank (Fig. 1.22). This is to improve the performance of the upper hopper tanks for the carriage of grain. Because these tanks are designed to carry grain, feeder ports are fitted at the base of the tank (Fig. 1.32). To allow the grain to flow from topside tank to hold the ports are unbolted and the plates removed before the grain is loaded. This allows the grain to feed into the hold as the cargo settles during the voyage and enables the balance of the contents of the topside tanks to flow into the hold during discharge.

Piping for the injection of *CO-2* gas, if fitted, may be attached to the upper hopper tank sides, or the gas may be injected through piping set into the hatch coaming, as is the case aboard the *Regina Oldendorff.* Forward and abaft the hatchway are small areas of hold deckhead (Fig. 1.24) beneath the masthouses. These are the positions where the hold access ladders are situated.

The *Regina Oldendorff* is unusually well provided with securing eye plates, also known as padeyes, in the holds (Fig. 1.23). These are provided as points of attachment for lashings to be used for securing steel and similar cargoes. To give access to the eyeplates permanent ladders are provided, ladders and eyeplates being in recessed positions protected from grab damage.

Features of larger bulk carriers: Panamax and Cape-sized bulkers usually have stool spaces and duct keels, features which are not normally found in handy-sized vessels.

Stool spaces: Larger bulk carriers are usually provided with stool spaces at the bases of their transverse bulkheads. Stool spaces are created by replacing the vertical lower part of the bulkhead with sloping sections of plating (Fig. 1.1 and others). These are similar to the side hopper tanks and fitted for a similar purpose, to feed the cargo closer to the hatch square (the area below the hatch coaming) where it is more accessible for grab discharge. The stool spaces are void spaces, spaces which remain empty during normal operations. Stool spaces are entered from the duct keel, and contain manholes which provide access to the double-bottom tanks.

Duct keel: This is a tunnel which extends along the ship's centreline, within the double bottom, from engineroom to the after end of No. 1 hold, or occasionally to the collision bulkhead (Fig.1.1). It usually contains the pipelines which connect the ballast tanks, bilges and fuel tanks to the pumps in the engineroom, and the associated valves, allowing easy access to them for repair and maintenance. The duct keel can be entered from the engineroom, usually by way of an opening secured with a bolted plate, and from an access trunk situated at the fore end of the ship and opening on deck. One or two other access trunks may be distributed along the length of the ship. The duct keel gives access to bilge and ballast valves for overhaul, though its restricted height often makes it an uncomfortable place in which to work.

On handy-sized and smaller ships and others with no duct keels, the ballast valves are located in the engineroom and the ballast lines pass through the double bottom ballast tanks.

Hatch covers: The *Regina Oldendorff* is equipped with MacGregor steel rackback folding hatch covers, with self-auto cleating. The hatch opening process is shown in Fig. 1.34, and the hatch retaining latches are shown in Fig. 1.26. The bolted ports set in the hatch lids (Fig. 1.25) are for loading bulk cement whilst the lids are closed, to reduce dust. Hatch covers are discussed in detail in Chapter 4, where rackback folding covers are illustrated.

Accommodation, machinery spaces, navigation bridge and poop deck: Set into the bridge front, and opening on to the upper deck are the CO2 bottle room and the tallyclerk's office. The *Regina Oldendorffhas* no cargo control room, so ballasting and deballasting procedures are controlled by engineering staff from the forward end of the engineroom lower plates (i.e. the lowest deck in the engineroom), where the necessary pumps and ballast valves are situated (Fig.1.28). Although this is a common arrangement, deck officers find it easier to control the ballast when an alternative system is installed with pumps and valves remotely operated by them from a cargo control room situated at the forward end of the accommodation, or in a masthouse.

The accommodation block is conventionally arranged with senior ranks accommodated on higher decks and towards the forward end. The ship's office adjoins the master's cabin and a similar office for the engineers is located next to the chief engineer's cabin. On larger bulkers the chief mate also usually has an office adjacent to his cabin.

The main engineroom entrance is in way of the changing room on the upper deck, port side, whilst an alternative entrance for heavy loads is available at the after end of the engineroom casing, with access from the poop deck by a hatch. Other doors at various levels in the accommodation also give access to the engineroom.

Within the engineroom the main engine is centrally situated, and the control room is forward on the port side on the 'A platform, the first level below the upper deck. The ship's steering gear is located right aft in a separate steering flat on the same deck. Storerooms, workshops, storage tanks and auxiliary machines are distributed amongst the 'A' and 'B' platforms and the engineroom lower plates in a normal manner. The emergency fire pump is located in a separate compartment directly abaft the engineroom.

The navigating bridge (Fig. 1.27), above the accommodation, is of conventional layout with chart table capable of being curtained off from the wheelhouse.

The poop deck is provided with port and starboard mooring winches, and with a centre hawse pipe and anchor on a wire rope. Provision cranes of 2 tonnes SWL are located at the after end of the boat deck, to port and starboard.

Hatch covers, ballast tanks and cranes are discussed in greater detail elsewhere in this book.

Sources

17 Tinsley, D., *Short-Sea Bulk Trades.* Fairplay Publications Ltd. 1984.

20 *The Bulk Carrier Register 1990.* Clarkson Research Studies Ltd., London. 1990.

21 Bell, Nigel, *The Freight Market—A Broker's View.* Bulktrans '91. CS Publications Ltd. 1991.

22 *Code of Safe Practice for Solid Bulk Cargoes.* International Maritime Organisation. 1989.

23 Gilfillan, Alan, *Developments in Bulk Carrier Design.* Bulktrans '89. CS Publications Ltd. 1989.

24 Buxton, Dr I.L., & Sen, Dr P. *The Economics of Operation ofVLBCs.* Bulktrans '89. CS Publications Ltd. 1989.

25 Wright, C., Wittington, M. & Currethers C. *Delivered Cost Benefits with Self Unloading Vessels.* Bulktrans '89. CS Publications Ltd. 1989.

26 Haram, H.K. *Large Bulk Carriers—Pushing Scale Economies Further.* Bulktrans '91. CS Publications Ltd. 1991.

27 Buxton, I.L. Daggitt, R.P., King, J. *Cargo Access Equipment for Merchant Ships.* E. & F.N. Spon Ltd. 1978.

(Sources are numbered in accordance with their position in the list ofsources and references on page 394.)

Chapter 2

CHARTERPARTIES

Charterparties, time charters, voyage charters, sub-chartering, voyage estimates, compliance with the charterparty, owners' and charterers' voyage orders, consultation with principals, master's responsibilities including interruptions to the voyage, keeping full records, surveys, and tendering of notice of readiness

THE AGREEMENT whereby a shipowner agrees to carry goods or to supply his vessel to carry goods is the contract of affreightment, and is the contract under which he is paid freight. The two principal types of contract of affreightment are charterparties and bills of lading. The former is between the shipowner and the charterers, and the latter is between the carrier (who may be the shipowner or the charterer) and the owner of the goods. Bills of lading are almost invariably issued even where the ship is chartered.

This chapter is concerned with charterparties, but it will be a fact that a bill of lading will also be issued. Its potential significance as representing the goods covered by it, and the fact that it will bind the shipowner or charterer, should be borne in mind by the master.

Bulk carriers usually operate in the charter market. Whilst some are time chartered for a period of months or years, many are employed under a voyage charter, or a time charter for a single voyage or trip.

Charterparties

A charterparty (C/P) is a contract for the hire of a ship, under which the shipowner provides the use of the ship for a specified period of time (a time charter) or for a specified voyage (a voyage charter), and the charterer pays for the hire or freight and, usually, finds the cargoes. (Occasionally the charter is by demise, or bareboat; under such conditions the charterer becomes in effect the temporary owner of the vessel and employs his own master and crew. Such arrangements have not been discussed in this volume). Under a time or voyage charter the master is employed by the owner, but will receive instructions from both the owner and the charterer. Under both types of charter it is usually implied that the ship will perform her services with reasonable diligence, and without deviation.

Time charters: A time charterparty is a contract to hire the ship for a stated period, short or long term, against an agreed payment (hire). The charterparty may allow the period to be extended or shortened, and there is likely to be some flexibility about the date for starting and ending the charterparty, to allow for the completion of the preceding and following voyages. Such time charters are known as period charters. Alternatively, the time charter may be for a single voyage-for example, 'one time charter voyage', or 'one North Atlantic round voyage'-where the period of the charter is the time necessary to perform the voyage or trip, often called a time trip charter. For any time charter the hire of the vessel will be at a certain daily, weekly or monthly rate, and may be based on the tonnage of the vessel-e.g., 'six thousand US dollars per day'-which will be stated in the charterparty. A lumpsum ballast bonus may also be paid to compensate the owner for part of the cost of delivering the ship at the loading port.

Under time charters the owner appoints master and crew and normally pays for crew wages, hull and machinery and P & I insurances, provisions, stores and spares, lubricating oils, fresh water, repairs and maintenance and delays caused thereby. There will also usually be express obligations as to the seaworthiness of the ship, and the requirement to maintain her during the period of the time charter.

The owner is also required to pay for other items as agreed in the charterparty. Such items may include initial hold cleaning, off hire survey (or 50 per cent of joint on/off survey), time lost due to plant breakdown, cost of temporary cargo equipment to cover breakdown of ship's gear, fuel for domestic cooking and lighting, deviation expenses, bunkers and diesel oil on redelivery at the end of the charter, fines due to the ship's operations, and non-compulsory tugs and pilotage. Pilotage which is 'usual for the trade', or 'recommended', is usually for charterer's account.

For cargo claims the charter may include the Hague/Hague Visby Rules regime of rights and liabilities. Also included may be provisions stating how liability will be shared between owners and charterers in respect of certain types of cargo claim, though such provisions are less common when dealing with bulk cargoes.

The charterer will normally be required to pay for daily hire, the cost of bunkers delivered and consumed during the charter period, port charges and canal dues, and stevedoring costs. In addition the charterparty is likely to require the charterer to pay for compulsory tugs and pilotage, additional insurance premiums for breaking Institute Warranty Limits, and trading in war zones, hold cleaning by crew during charter and on redelivery, supply and labour for the application of special hold coatings, supply of special cargo fittings and dunnage, cargo fumigations, victualling of clerks and supercargoes, on hire survey (or 50 per cent of joint on/off surveys), radio communications and reasonable entertainment costs. The charterer may have the option of redelivering the vessel dirty if he makes a payment in lieu of hold cleaning.

A time charter invariably contains an off-hire clause for the benefit of the charterer. If the ship is not in full working order to provide the services required and there is a loss of time because of that failure, then the charterer is not liable for hire or the cost of bunkers for the time so lost. This provision is likely to be enforced in event of a failure of the ship's cargo gear, or an arrest of the ship for smuggling or some such offence.

A time charterparty will normally stipulate the service speed and fuel consumption to be achieved in good weather conditions, by the vessel when loaded and in ballast. Good weather is sometimes defined in the charterparty as 'wind speed not exceeding 16 knots', and the C/P may state that wind speed data provided by weather routeing organisations will be favoured over that contained in the ship's log book if there is disagreement. This arbitrary system takes no account of wind directions, or of currents and swell, despite the fact that these have the greatest effect on a vessel's speed. In addition to the service speed, many charterparties quote one or more economical speeds, with corresponding consumptions, these figures usually being 'without guarantee' (WOG).

Apparent failure to achieve the speed and consumption required by the charterparty may be a cause of dispute (underperformance or overconsumption claims brought by the charterer) and it is important that the master records accurately the speed, fuel consumption, weather conditions, stoppages, changes of course, currents, damage to the vessel, changes in trim or displacement and any other factors influencing the performance of the vessel during the charter period in the deck and engineroom logs, since there is scope for both owner and charterer to manipulate the situation to secure an advantage or conceal a deficiency. A master should be alert to ensure that his ship is achieving the required performance, and should be ready to explain any failure to do so.

Stevedore damage is usually settled directly between the owner and the stevedore, with agreed assistance from the charterer. Under a time charter the stevedore is usually the servant of the charterer, so stevedore damage is ultimately the charterer's responsibility. However, most C/Ps state that written notice of liability must be tendered by the ship to the party causing damage within 24 hours of the occurrence, and it may be practical and indeed necessary for the master to deal with the matter on the spot. In this way the charterer steps out of the procedure. However, if such notice is given and the stevedore fails to compensate for the damage, the shipowner will claim against the charterer direct. If notice of damage is not given to the stevedore, the charterer may escape his liabilities. If the damage caused by the stevedore is not discovered until later, because it is not apparent, the shipowner will claim against the charterer.

Voyage charters: A voyage charterparty is a contract to hire the ship for the carriage of specified goods on a defined voyage or voyages between specified ports or regions, for an agreed payment (freight) which may depend upon the quantity of cargo loaded or carried (for example, US$12 per tonne) or which may be lumpsum (for example, US$900,000), a gross sum paid for the use of the whole or part of a ship.

The voyage charter will almost always provide for a fixed time for loading and unloading the vessel. This is called laytime, and is paid for by the charterer in his freight. Laytime may be expressed as 'X thousand tonnes per weather working day', in which case the laytime will depend upon the tonnage loaded. (If no laytime is stipulated, then there is an implied agreement that the charterer will load and discharge the cargo within a reasonable time.)

Similarly, the voyage charter will almost always provide a rate at which the charterer must pay the owner if he fails to load and unload the vessel within her laytime. This is called demurrage. If no demurrage rate is stipulated, then the charterer will be liable to damages for failing to load or discharge within laytime or a reasonable time.

The law relating to laytime and demurrage is complicated, and standard form charterparties contain different schemes which may lead to different results in different cases. It is not proposed to deal with those here. However, as disputes between owners and charterers frequently arise in this area, comment on the master's role in giving the notice of readiness (NOR) which usually triggers the commencement of laytime has been included below.

A voyage charter will also usually provide for a dispatch rate. When the charterer succeeds in loading or discharging the vessel in less than the time allowed under the charter, he will be entitled to receive dispatch from the owner at the rate provided. The benefit to the owner is that he obtains the use of his vessel again more quickly. The dispatch rate is usually 50 per cent of the demurrage rate.

Sub-chartering: It is quite common for a vessel to be hired by a charterer from the owner under one charterparty (head charter) and then sub-chartered by the first charterer to a sub-charterer under a second charterparty (sub-charter). There maybe one or more sub-charters and these may be time or voyage charters, although generally the last charter in the chain will be a voyage charter. In this situation the first (and any other intermediate) charterer becomes known as the disponent owner, and is responsible to the sub-charterer for the owner's obligations. The first charterer remains responsible to the owner for performance of the head charter, but the master should be aware of the terms of both charters in case of conflicting instructions from disponent owners and sub-charterers. He should ensure that the instructions he receives are clear and unambiguous, and should have a clear understanding of the identities of the parties and the separate requirements of each with respect to reporting and consultation.

Voyage estimate

When a ship is coming to the end of a charter, the shipowner's commercial manager will instruct the company's shipbroker to find a charterer and fix the ship for further employment. The broker, knowing the owner's policy, the particulars of the ship, the state of the market and the movements of commodities, will seek to obtain the best return he can.

Once a potential charterer has been found to offer a particular cargo, the company will complete a voyage estimate to see if the voyage will be profitable. Even a loss-making voyage may be acceptable if it will take the vessel to a convenient area for a subsequent profitable cargo, or for other necessary ship's business such as a drydocking or crew change.

As noted above, the earnings of a ship employed under a time charter are governed by the rate of hire and the number of days for which the charter lasts. whilst those of a ship fixed under a voyage charter depend upon the tonnage carried and the rate per tonne. The costs which the shipowner must meet from these earnings also differ from one charter to another. In the case of a time charter it is generally only the owner's running costs which must be deducted to arrive at an estimate of the profitability of the business. In the case of voyage charters, however, the position is more complicated.

The object of voyage estimating is to calculate the approximate return on a voyage after deducting expenses from the expected income. In the case of a voyage charter it is usual to start by examining the time each section of a voyage will take, commencing with the ballast passage from the time of dropping the outward pilot at the previous discharge port. Time in the loading and discharging ports will be assessed, taking account of possible holiday periods, and time required for the loaded voyage will also be considered. Factors to consider include the customs of the trade, the opportunities for obtaining bunkers, canal transits and seasonal conditions.

Estimating time for cargo loading and discharge requires much experience. It depends upon the quantity of cargo to be handled, the rate at which it can be delivered to or taken away from the ship, the capacity of the ship's or shore gear for cargo handling, and the likelihood of delays and interruptions to cargo work because of weather, or for other reasons.

Having costed the time, expenses have to be calculated. This involves bunkers, port charges, light dues, towage and pilotage fees, berth dues and other special items like canal tolls and extra insurance for breaking Institute Warranty Limits. Charterers will often be required to pay the extra premium required by the ship's underwriters to trade the vessel outside Institute Warranty Limits or in war zones.

Running expenses take account of such items as crew costs, repatriation, repairs and maintenance to the ship, fresh water, garbage and slop disposal, insurance premiums, depreciation and administration overheads. It is usual to calculate them separately as part of the company's normal budgeting procedures, and they will be known to the person completing the voyage calculation.

A typical voyage estimate (Fig.2.1) for a ship on voyage charter from Brazil to Iran with a cargo of soya bean meal is calculated in US dollars. It shows expected freight payable on 24,500 tonnes of cargo, plus demurrage payable for three days. Expected costs include commissions, fuel, port charges, insurance payments and payment for despatch. The anticipated time at sea, time in port, fuel consumption, fuel costs and port charges are summarised towards the bottom of the form. The voyage estimate shows net earnings of US$8,929 per day. The calculations show that the voyage would be profitable if the ship's daily running costs (or overheads) were less than that figure.

The fixing of any charter is normally a process of negotiation, and it is likely that proposals and counter-proposals will pass between the brokers representing the charterer and the owner before the final terms of the charter party are agreed.

The voyage estimate form has space for the insertion of 'Actuals', and the actual earnings and costs will be entered as they become known, so that the profitability of the voyage can be seen. Comparison of the estimates with the actuals also helps to improve the quality of future estimating.

Confirmation that proposed cargo can be carried: When attempts are being made to fix the ship, the broker may contact the master to request his confirmation that a cargo can be safely carried and his calculation of the tonnage that the ship can carry between specified ports. This is particularly important, and particularly well advised, when the cargo is composed of several parcels to be loaded or discharged in different ports and to be carried in separate holds. The calculations in such cases can be complex and the limiting factor may not be obvious. Another possibility might be that the ship was unsuitable for a particular cargo because of hold configuration or dimensions, permissible stress limits or tanktop loadings, or amount of ventilation which could be provided.

Expensive mistakes can be avoided if the ship's master and officers check any calculations which have been undertaken by the broker or head office staff. Although it may be frustrating for those aboard ship to be asked to investigate a succession of possible charter voyages which are never confirmed, the results which they produce can help to avoid mistakes.

When the ship has been fixed: There are many different standard charterparty forms, and they are invariably used in amended form, with numerous additions to and deletions from the basic printed wording. Normally a charter party also has attached to it a large number of additional typed clauses ('additional' or 'rider' clauses) as agreed by the negotiating parties. Sometimes a charter will contain the charterer's standard terms which will be more favourable to him.

Many of these clauses are concerned with methods of payment, settling of disputes, insurances and other matters with which the master will have little or no involvement, but many other clauses deal with matters which are his responsibility and with which he will be directly involved. As a very general rule the additional clauses will prevail over the standard wording, and clauses specifically dealing with a particular circumstance will prevail over a general clause.

Knowledge of the terms of the charterparty and compliance with them

If a ship is to comply fully with the terms of her charterparty, she will need to be maintained in a seaworthy condition with all her equipment and fittings in good working order and to be operated efficiently. In addition, the master and crew must act in accordance with the terms of the charterparty. In normal circumstances this can be achieved by carefully following the instructions contained in the voyage orders from owners and charterers. The master and chief mate should both study the contents of the voyage orders with care, and all other officers should be informed of these orders as they affect them.

The master should study the full contents of the charterparty, provided that a copy is available to him, as it always should be. It is cause for concern that the master frequently is not provided with a copy of the charterparty, and he should not hesitate to insist upon being provided with a legible copy to enable him to make intelligent decisions on the running of his ship. It has been known for charterers' orders to contain instructions which are claimed, incorrectly, to be

VESSEL ________ DATE ________ COMMODITY Soya Bean Meal 52ft

VOYAGE Rio G Do Sol + Iran CHARTER Irisl

			ACTUALS
FREIGHT 24500 AT 40.08		980000	
DEMURRAGE 3 DAYS AT $7500 PER DAY		22500	
COMMISIONS 6¼% TTL	62656		
FUEL	178019		
PORT CHARGES	89000		
~~CANAL~~ WAR INS PANDI $7500 WAR CREW BONUS 27 days $50598	58098		
DESPATCH 2 DAYS AT $3750 PER DAY	7500		
TIME ~~/~~ DAYS AT TTL ~~PER DAY~~	395273	1002500	
NET		607227	
EARNINGS			

VOYAGE DAYS 68

TERMS OF CHARTER ETC.	
DATES	LAYCAN 12.7.88
RATE	40/41.8 + 0.50$
LAYTIME	3500/2000
COMM.	6¼%

CREW WAR RISK $1874 per day

14KTS = 35 + 2.5 4.0 PORT

CARGO $\frac{1,300,000 \text{ cu ft}}{52} = 24500$

$8929 PER DAY

—

FROM	TO	MILES	DAYS AT SEA	DAYS IN PORT	EST. BUNKS. CONSUMPTION F.O.	EST. BUNKS. CONSUMPTION D.O.	$ COST/TON F.O.	$ COST/TON D.O.	ESTIM. FUEL COSTS	ESTIM. PORT CHARGES	ACTUAL ITEMS	ACTUAL COSTS
R G Do S	Paranagua	405	1	10	36	3	89	270	4314	15000 Rio		
Para:	B. Abbas	8625	26	16	910	65	89	270	98540	4000 Para		
Lisbon	R G Do S	4934	15		480	37	90	105	47085	70000 Basas		
			.	26		104		270	28080			
TOTALS			42	36					178019	89,000		

FIG 2.1 (VOYAGE ESTIMATE FORM FROM VOYAGE ESTIMATING BY WILLIAM PACKARD)

taken from the charterparty. Without a copy of the charterparty, the master is unable to be fully aware of his rights and responsibilities and to ensure that the orders he is given are valid.

Sometimes even the owners sign a charterparty without fully appreciating the meaning of all the clauses. An alert master may spot discrepancies between the charterparty and the voyage instructions from owners or charterers.

The master will also receive from his owners and charterers extensive voyage orders, transmitted by facsimile, telex or mail, which contain such extracts of the charterparty as each party considers it is necessary for him to know.

Owners' time charter voyage orders: The owners' voyage orders for a time charter voyage are likely to provide details of who the charterers are, the charterparty date, details of delivery, laydays and cancelling date, the voyage, and the date and place of redelivery. Instructions regarding speed of the vessel and consumption of fuel will be included, and these may be accompanied by notice of acceptable loading and discharging sequences of which the charterers have been informed.

The sense of charterparty clauses relating to important matters such as lying aground, cargo to be loaded under the supervision and direction of the master, appointment of charterers' supercargo, quantity of bunkers on redelivery and option of bunkering for owners' account, authority for charterers to sign bills of lading in accordance with mate's or tally clerk's receipts, and action to be taken in event of stevedores' damage will also be reproduced in the owners' voyage orders.

The owners' voyage orders may remind the master to ensure that all invoices for the charterers' account are endorsed with a stamp stating: 'The goods and/or services being hereby ordered, acknowledged and/or receipted for, are being ordered and/or accepted solely for the account of charterers of the mv .... and not for the account of said vessel or her owners. Accordingly, no lien or other claim against said vessel can arise therefrom.'

The orders may conclude with instructions to the master to report at the time of redelivery on hold condition, fuel remaining and costs incurred by charterers in respect of subsistence and gratuities.

Charterers' voyage orders: Since the charterers' interests and responsibilities are different from those of the owners, their voyage orders are likely to concentrate upon different matters.

After providing the same basic information as the owners with respect to their own identity, the charterparty date, details of delivery, laydays and cancelling date, the voyage, date and place of redelivery and instructions regarding speed and consumption, the charterers will normally provide details of the intended cargo, and ask the master to prepare and submit a stowage plan. Requirements for ETA (estimated time of arrival) will be stated, and details of the charterers' agents will be provided. Most importantly the authority, if any, to be given by the master to charterers or their agents for the signing of bills of lading will be stated. Proposed bunkering intentions will be advised.

At some stage in the voyage the charterers will provide a list of discharge ports, and if appropriate they will state the maximum permitted drafts and cargo to be discharged in each, such information being necessary at an early stage if proper planning is to be achieved. They will also provide details of whether the quantity of cargo loaded and discharged is to be assessed by draft survey or shore scales, to determine bill of lading weight.

Arrangements for using a weather routeing service may be described, and the requirement for reporting noon position, average daily consumption, speed, weather and ETA whilst at sea, and for providing an arrival report on completion of each passage will be stated. The master will be advised of which radio stations to monitor and of the preferred method of sending and coding communications. He will also be told how to address both routine and emergency messages, and is likely to be reminded that he must provide the charterers with log abstracts.

Consultation with owners and charterers: Most shipmasters know that they should consult their owners and charterers whenever an unusual situation arises. This permits the other parties to remind the master of his rights and responsibilities under the charterparty, should that be necessary. Failure to comply with the terms of the charterparty can be expensive, so the master should consult his documents and his principals whenever he is in doubt.

Master's responsibilities

The master is, nowadays, almost always in a position to communicate with the owner and/or the cargo owner by telex, fax or telephone for instructions in difficult or extraordinary situations. For this reason, the master's powers, in certain circumstances, to sell damaged goods, to transship goods, to raise money on cargo or the vessel, or to jettison goods have not been discussed.

General responsibilities: The master's overriding obligation remains at all times to protect the lives of passengers and crew, and to ensure the safety of the vessel. In addition he is responsible to international, national and local authorities for compliance with regulations, including the prevention of pollution and care for the needs of his crew. The commercial contracts entered into by the owner require him to preserve and care for the cargo on board, and to carry it safely and with reasonable dispatch. Thereafter the master has to use his best judgement to ensure the optimum performance of the ship whilst complying with the various commercial contracts to which he or the owner is a party.

On a voyage the master must do what is necessary to carry out the contract of carriage and to take reasonable care of the goods entrusted to him. In doing so he acts as the agent of the shipowner but, because of his possession of the cargo, he may also act as the agent of the cargo owner in protecting the cargo owner's interest in the cargo.

The master is the owner's agent in providing 'necessaries' for the voyage which under the charter are to be provided by the owner, but he is the charterer's agent for providing 'necessaries' to be paid for by the charterers-for example, bunkers under a time charter.

The master, in taking reasonable care of the goods entrusted to him, should do what is necessary to preserve them on board during the ordinary incidents of the voyage-for example, by ventilation, or by pumping bilges. He should also take reasonable measures to prevent or check loss or deterioration of the goods.

Unless the charterparty expressly provides otherwise the master should proceed by a usual and reasonable route without unjustifiable departure or unreasonable delay. Leaving the route will, however, be justifiable if done to save life, to communicate with a ship in distress, or because of some other necessary reason such as to carry out repairs or to avoid perils. Alternatively, the charterparty may contain an express liberty to deviate but-beware!-such deviation may incur offhire, even when done to save life.

Interruptions to the voyage: Whether under time charter or voyage charter, interruptions to the voyage due to failure of the ship, her equipment or her personnel will be costly for the shipowner. The means by which the shipowner is required to bear the cost of the failure vary from one charter to another, but the conclusion to be drawn is the same: the ship's master and officers should make every effort to ensure that no avoidable failures are allowed to occur.

In practice this means ensuring that the ship's machinery, both deck and engineroom, is maintained to a good standard and is operated with care by competent personnel who have received proper training in their tasks.

At the discharge port it is the duty of the master to proceed to the place of discharge if the charter provides for one. The holder of the bill of lading is usually entitled to have the goods delivered to him direct from the ship, if existing liens are satisfied. A shipowner may have a lien-i.e., a right to retain goods in his possession while he has unfulfilled claims against the charterer or the cargo owner. Such a claim might be, for example, for freight, for general average contributions, or for expenses incurred by the shipowner or master in protecting or preserving the goods carried. (The discharge of cargo against bills of lading is fully discussed in Chapter 14.)

The master may be asked to retain possession of the goods, either by keeping them on the vessel, or by maintaining them in the shipowner's possession-for example, by releasing them to a person or place where he retains control over them. The master may be able to deliver the goods to the person entided to them in the absence of a bill of lading, on receiving security or an indemnity against possible claims by others, but this is a matter which should be discussed with owners or their P & I clubs in advance.

Maintenance of full records: Disputes can only be settled when clear factual evidence can be supplied. To satisfy this requirement it is a further responsibility of the ship to ensure that detailed and accurate records are maintained throughout the charter period, with supporting documentation up to date, so that the times and circumstances of significant events can be confirmed.

A checklist of data and records to be kept is given at the end of Chapter 3, and the subject is covered in detail in *The Masters Role in Collecting Evidence.*[189]

Surveys required by the charterparty: It is usual to have certain matters relevant to the charterparty, such as hold cleanliness and tonnage of cargo loaded, surveyed by independent surveyors, but ship's officers should always check the results obtained by surveyors and make their own assessment. Where they disagree with the conclusions reached by the surveyor, the master may record this by endorsing the surveyor's report if he is required to sign it, by serving a notice of protest, or by making an entry is the ship's deck log book, as appropriate. He should consult his owners as far as is possible and should take great care before clausing bills of lading, mate's receipts or other documents evidencing the quantity, quality and condition of the goods loaded.

The start and finish of the charter period are normally marked by delivery and redelivery surveys. The purpose of these surveys is to observe and record the condition of the ship and to measure the bunkers aboard at both ends of the charter period. The results of the survey provide the facts required for settlement between owner and charterer of any claim for damage to the ship, or bunkers consumed or remaining. The survey is normally undertaken by a surveyor representing the charterer. A second surveyor, or the ship's master or chief mate, will represent the owner.

A delivery or redelivery survey requires the listing of every item of damage in the holds and adjacent cargo working areas, and the sounding of all bunker tanks and measurement of bunker temperatures in the company of the chief engineer. In cases where the redelivery survey takes place in the discharging port, but the charter ends on dropping the outward pilot, for example, the measured bunker quantities must be corrected for the quantity of bunkers to be consumed from time of survey to time when the charter ends.

On-hire and off-hire surveys can be the same as delivery and redelivery surveys, but can also be required during the course of a charter, if for any reason the vessel goes off hire.

Tendering of notice of readiness: The tendering of notice of readiness (NOR) is an important part of the process of making or resisting claims for despatch and demurrage, matters which were discussed in the paragraphs on voyage charters.

It is usual for a voyage charter to specify two dates and to provide that laytime cannot commence before an earlier date and that if the ship is not ready by the later date the charters have the option to cancel the charterparty. The period between the two dates is called the 'laycan spread'. A valid notice of readiness may be given at any time, but laytime cannot commence before the date given in the charter.

The master does have an important role to play by tendering the notice of readiness to load or discharge, and he and his officers can maximise the vessel's earnings by ensuring that no delays to loading or discharge can be blamed upon the ship.

Laytime will usually commence at a time dependent upon the time when the NOR is correctly tendered and/or received, depending upon the terms of the charter. It is the master's responsibility to ensure that the NOR is correctly tendered, and the wording of the charterparty will normally state when, in what circumstances, and how the NOR is to be tendered, or given, and to whom it must be tendered. The owners' or disponent owners' voyage orders can be expected to confirm what is required, but if in doubt the master should not hesitate to ask for clarification.

Under a voyage charterparty, a notice of readiness will usually be required at every loading and discharging port and may have to be tendered when the vessel arrives at the customary anchorage at the port (a port charter), or when she reaches the berth (a berth charter). It may be sufficient to have the vessel in all respects ready to load or discharge, but the charterparty may contain specific requirements-for example, that the vessel has passed a preloading survey-before notice of readiness is tendered.

The importance of the NOR makes it essential that the master retains written evidence that he has tendered the notice of readiness. This is normally achieved by endorsing the NOR with the date and time that it is handed to the charterer's agent, obtaining the agent's signature for receipt, and retaining a copy. Where it is not possible to tender notice of readiness by placing the document in the agent's hand, because the ship is at an anchorage or because the agent has failed to visit the ship, then NOR should be tendered by radio telegraph, by telex or by facsimile, using any method which provides proof of delivery.

A common provision is a requirement that the notice be given during office hours. If there is such a provision and the notice is given outside office hours, the notice will probably be treated as though it was given at the commencement of working hours on the next working day. In Muslim countries offices may be closed on Fridays and Saturdays, a point on which the charterparty will normally give guidance.

In view of the commercial importance of the tendering of NOR, it is a widespread practice for shipmasters to tender notice of readiness on arrival in any loading or discharging port, provided that the vessel is ready to work cargo and regardless of whether or not they know the vessel to be on voyage charter. This is a safe practice to adopt.

If NOR is not received by the shore, the master should keep tendering NORs until received. Each NOR after the first should include above the master's signature the phrase: This NOR is tendered without prejudice to the validity of NORs previously tendered'. In these circumstances NORs should be tendered twice daily, and also at any appropriate time, such as when another ship berths or unberths at the intended berth. (An example of a notice of readiness has been included in Chapter 14).

Summary

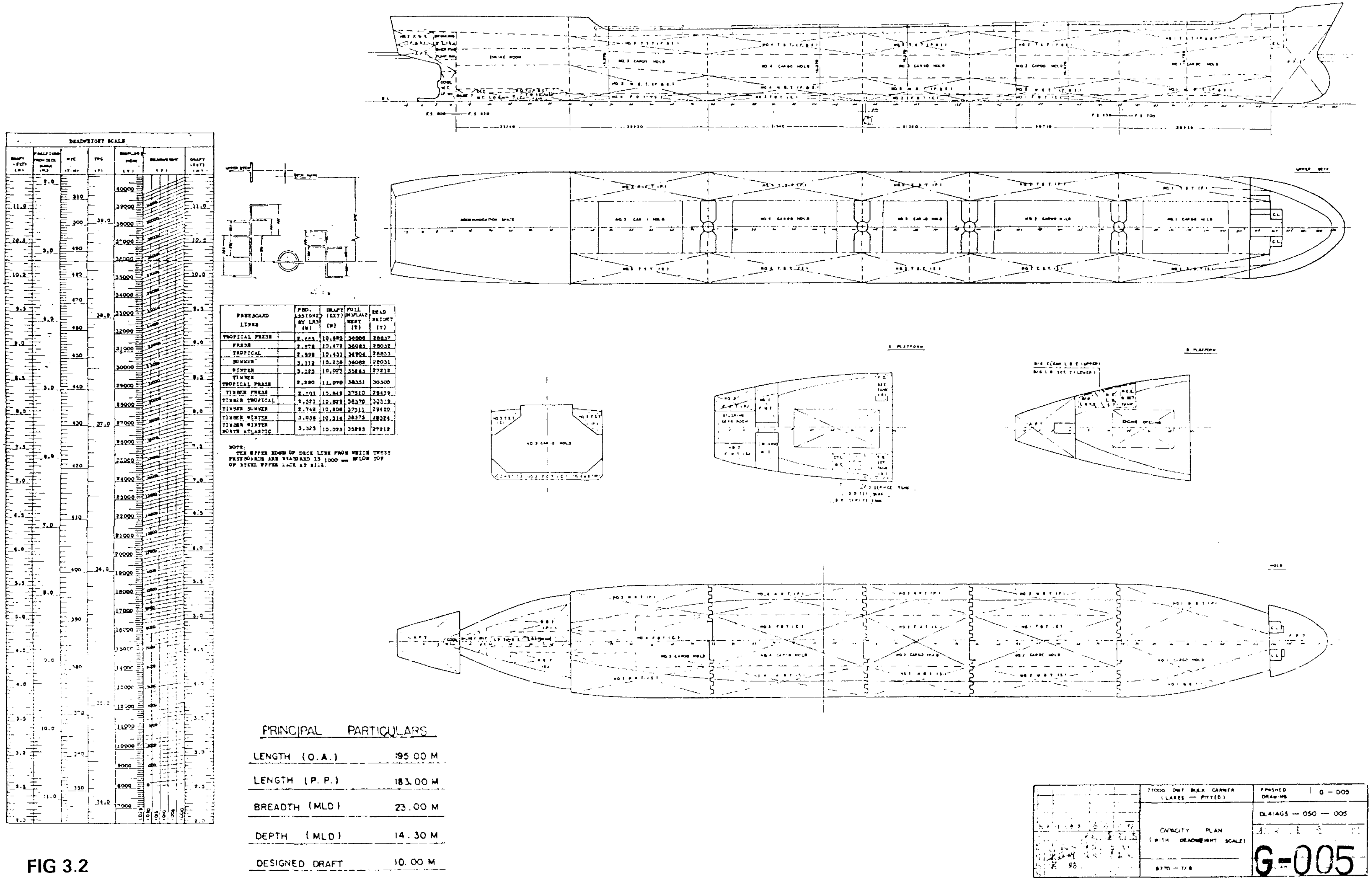
A shipmaster cannot hope to control and to optimise the performance of his ship unless he is familiar with the contracts which govern her trading. If a shipmaster is to do his job properly, he must know and understand the terms of the charter parties under which the ship is operating and ensure that his officers are well informed; he must operate and maintain the ship in an efficient manner and keep full and accurate records.

Sources

13 Durham, C.F. **FRMetS,** MNI. *Marine Surveys.* Fairplay Publications. 1982.

189 *The Master's Role in Collecting Evidence.* The Nautical Institute. 1989

REGINA OLDENDORFF - CAPACITY PLAN
(Reduced to 1/9th its original size)



FREEBOARD LINES	FBD. ASSIGNED BY LRS (M)	DRAFT (EXT) (M)	FULL DISPLACEMENT (T)	DEAD WEIGHT (T)
TROPICAL FRESH	[illegible]	10.683	36006	28637
FRESH	2.978	10.478	36083	28037
TROPICAL	2.998	10.451	36904	28633
SUMMER	3.112	10.238	36062	28031
WINTER	3.323	10.025	35863	27212
TIMBER TROPICAL FRESH	2.280	11.070	38351	30300
TIMBER FRESH	2.301	10.849	37510	29439
TIMBER TROPICAL	2.321	10.829	38379	30319
TIMBER SUMMER	2.742	10.808	37511	29480
TIMBER WINTER	3.036	10.314	36375	28324
TIMBER WINTER NORTH ATLANTIC	3.325	10.025	35863	27212

NOTE:
THE UPPER EDGE OF DECK LINE FROM WHICH THESE FREEBOARDS ARE MEASURED IS 1000 mm BELOW TOP OF STEEL UPPER DECK AT SIDE.

PRINCIPAL PARTICULARS

LENGTH (O.A.)	195.00 M
LENGTH (P.P.)	183.00 M
BREADTH (MLD)	23.00 M
DEPTH (MLD)	14.30 M
DESIGNED DRAFT	10.00 M

FIG 3.2

Chapter 3

LOG BOOKS, RECORDS AND REFERENCE BOOKS

The records which should be maintained aboard bulk carriers because of their trade, the reference books which ought to be available for routine inspection, and the drawings required by deck officers

Records which should be maintained

NO MORE than brief mention is made in this chapter of routine records such as are required for all ships. The main purpose of the chapter is to draw attention to records and to log entries which may have particular significance for bulk carriers and their cargoes.

Log books-sea voyage: During the sea voyage, the chief mate's log book (otherwise known as the deck log book) should contain routine navigational information including positions at regular intervals and method of position fixing, courses steered, allowances made for compass error, leeway and set. These data should be recorded when observations are taken, or at the end of the navigational watch, as appropriate. The record of course, distance and speed made good, and course and distance to go should be completed daily and a full set of routine weather observations, with a report of sea and swell conditions, should be entered at the end of each watch.

Details of severe weather met and the action taken should be recorded. For example, the log book should record when the vessel has been hove-to in adverse weather, or when course has been altered to avoid a tropical storm. In addition, the log book should contain full details of any matters which might affect the cargo and its condition.

When a cargo which requires ventilation is being carried, ventilation of the holds should be recorded in detail, stating times of starting and stopping, and give the reason for stopping ventilation. Such a reason might be *Shipping water and/or spray over hatches,* or *High humidity of ambient air.* Where the ventilation programme is influenced by the air humidity, regular hygrometer readings (wet and dry bulb) should also appear in the log book once per watch, or more often if a sensitive cargo requires more frequent readings.

The nature of the ventilation should also be fully recorded, stating which ventilators are being used if there are alternatives, and whether the ventilation is mechanical or forced draft (i.e., by fan) or natural draft (natural flow of air through the ventilation cowl). Where fans are used, the log book entry should show whether they are drawing air into the compartment (suction or inlet mode) or blowing air out from the compartment (exhaust or outlet mode), and whether they are being run at full speed, half speed or some other value. Differences between the ventilation given to different holds should be clearly recorded.

Suitable log book entries might read: *0800 Ventilation of holds Nos 1-7 commenced with all afterfans at full speed in inlet mode, and all forward vents on natural ventilation. 1800 ventilation of holds Nos 1-7 stopped and all vent flaps dosed in accordance with shippers carrying instructions.*

Heavy rainfall and the shipping of water and spray over decks and hatches must also be recorded in the log book when experienced, as this may be relevant if cargo is subsequently discovered to have suffered wet damage.

The dates and times of any hold or hatch cover inspections during the voyage should be recorded, with the name and/or rank of the person making the inspection, the nature of the inspection and any findings. An appropriate entry for a cargo of steel coils might read: *1000-1200 Inspection of all holds and hatches by chief mate and bosun, to see if any cargo had shifted. All well.*

A more serious situation could be reported in the deck log book as follows: *1500. During routine cargo inspection by chief mate and bosun damage/shifting found in holds Nos. 2 and 5. Resecuring not possible. Course adjusted to minimise further damage.* Such an incident would, of course, also require immediate reports by the master to his owners and charterers, and it would be necessary at the first opportunity to prepare a detailed report of the damage to ship and to cargo, and the circumstances in which the damage occurred.

Further information which should be recorded in the log book includes the records of cargo temperatures when observed (for example, when carrying coal cargoes), the pH readings of bilge water and the volumes or tonnages of bilge water pumped out, plus readings obtained with methanometers, O_2 meters, etc.

If there is insufficient space on the log book page for the clear entry of all the necessary detail, then additional sheets of paper must be attached to the log book with the extra detail which is required. Soundings of all compartments including hold bilges, ballast tanks, fresh-water and oil-fuel tanks, cofferdams, void spaces, chain lockers and other spaces should be taken and recorded in the log book at least once daily.

It is not acceptable for an empty tank to be recorded simply as *empty* (often abbreviated to *MT).* The difference between a 10cm and a 20cm sounding in the ballast tank of a large ship can be considerable in terms of tonnes of ballast water, and any increase in water level needs to be detected and investigated in view of the possibility of leakage. This consideration is of particular importance when a ship is cargo laden, since the cargo may be exposed to the risk of water damage if water is entering some part of the ship undetected. A reader who finds *MT* recorded in the sounding book instead of a small sounding such a *5cm* or *12cm* will suspect that no soundings have been taken, and that the entry reflects the reported state of the tank and not the actual sounding.

During a ballast passage the testing of any cargo care systems should be recorded in the log book when carried out. Such entries might include the testing of hold bilge pumping systems, hold ventilation fans and hold CO_2 smothering systems. The testing of hatch cover watertightness by hose test or by chalk test should also be recorded, as should the result, and any remedial action taken.

A typical series of log book entries would be: *1030-1130 Hose tested Nos. 1 and 2 hatch covers for water-tightness under supervision of chief mate. Leakage found only at No 2 starboard side. 1530Following routine renewals and adjustments to fittings of No 2 hatch cover the covers were again hose tested, and were found to be watertight.*

The log book should contain records of such matters affecting the cargo and the operation of the ship as the inspection and tightening of cargo lashings, details of in-transit fumigation, and the changing of ship's ballast to comply with pollution regulations, or for purposes of draft and trim.

Log books-in port: A *Statement of Facts* is normally produced by the ship's agent to cover the time spent in a loading or discharge port. The agent will usually rely upon the ship's staff to provide some of the times and facts which are included in the statement, and the shipmaster should satisfy himself before signing the statement that the information it contains is accurate, since it will be used to calculate the value of any demurrage or despatch payments or to settle any disputes which may arise regarding the voyage.

The chief mate's log book will record significant times such as the times of dropping anchor off the port, reaching the fairway buoy, arriving at the berth and tendering notice of readiness. The log book will be supported by the more detailed and comprehensive entries contained in the bell book (also known as the movement book, or bridge note book), which is the working document in which events are recorded at the time they occur.

It is essential that weather observations are continued whilst the ship is in port and they should be recorded at least three times daily-for example, at 0600, 1400, and 2000. When officers continue watches in port, the weather should be recorded at the end of each watch, throughout night and day. In addition, any exceptional weather conditions which may interrupt cargo work, damage the cargo or damage the ship should be recorded whenever they occur.

The log book should record any surveys which are requested and which take place, and their result, and any protests which are made or received. Fumigation of cargo holds should be recorded, with details of the treatment given, the purpose of the treatment and who ordered it. The sealing of holds, if required, should be noted and inspections of the seals should be recorded.

Notebook or cargo log: Once in the berth, it is necessary to record details of starts, stoppages and completions of cargo work and transfers of cargo-handling equipment, along with tonnages and positions of ballast and fresh water loaded or discharged, soundings observed, and tonnages of cargo advised or calculated. The records should show the times that work started and stopped at each hold and the durations of all surveys and inspections. Tonnages of bunkers taken should be recorded, as should details of all accidents to ship and personnel.

These records are likely to be kept in the first instance in a note book in the possession of the duty officer, or in a cargo log book kept in the ship's office or cargo control room. The cargo log book, when used, is similar to the bell book: it is the working document in which full records of all relevant data should be recorded. The use of a cargo log book providing a complete record of cargo, ballast and associated operations is to be recommended. Times of working cargo and reasons for stoppages will normally be copied, into the deck log book from the cargo log or officer's notebook at the end of each watch, but the details of the working of ballast will not normally be transferred.

It is most important to ensure that stoppages are accurately timed, and that the reasons for them are discovered and recorded. This information can be most important for the ship in the event of a dispute. Drafts should be recorded on arrival and departure and at appropriate times throughout the port stay. During a discharging operation extending over several days, it is appropriate to take draft readings each morning and evening. When loading draft readings should be taken and recorded at the end of each stage in the loading.

The cargo log or personal notebook is a document maintained by a duty officer who may be working in dirty and difficult conditions. The cargo log is best maintained in a readable condition if immediate notes are kept in a notebook for transfer to the cargo log on next return to the ship's office or cargo control room. The cargo log and personal notebooks should always be retained, as they will be required as evidence in the event of a dispute and will carry more weight than a document which has been written up after the event.

Cargo documents: Copies of all cargo documents given to the ship, or presented for signature, should be retained. (The documents likely to be met are described in Chapter 14.)

Damage records-damage to ship or cargo: It is vital that full records are kept of damage which occurs to ship or to cargo during loading or discharge. Some owners and charterers provide well designed 'stevedore damage' forms for such records but others are less suitable and a badly designed form may fail to provide all the necessary information, even when each space contains an entry. A well-designed form, such as the sample at Appendix 3.1), when completed will provide a full record of when, where and how the damage occurred and will contain a detailed description of the damage sustained.

As with all reports, sufficient information should be given to enable a reader with a professional knowledge of the subject to form a clear and accurate picture of the circumstances of the damage. Accurate measurements should be recorded, supported by photographs where possible. In the case of more substantial items of damage, when likely costs are to be measured in thousands of dollars, not tens of dollars, extensive detailed records will be required. The Nautical Institute's book *The Masters Role in Collecting Evidence*[lm] provides full guidance for this situation.

Trim, stability and stress calculations: The trim, stability and stress calculations which are undertaken when planning the loading of a bulk cargo may be done with pencil and paper, or by lodicator from which readings are read, or by computer which provides a printout of the results. The alternative which is used will depend upon the facilities available aboard the ship which may, in some cases, include computers which are the personal property of officers.

Whichever method is used a record of the calculations, with weights and assumed positions, should be kept, along with the values obtained from the calculations. Full details of the eventual departure condition on completion of loading should also be retained and filed for later inspection. These results may be useful in the planning of future cargoes or can provide answers to questions which may arise later concerning the present cargo.

The Nautical Institute also recommends completion of a Cargo Operations Control Form, described in Chapter 9. The procedures for the calculation of stability are discussed in Chapter 10.

Draft survey calculations: The ship's calculations of the quantity of cargo by draft survey should be retained for inspection at a later date, if required. When an independent surveyor is appointed to make a draft survey, a copy of the results of his survey should be kept aboard along with the ship's own calculations, which should be done independently. (Procedures for the conduct of a draft survey are described in Chapter 13.)

Cargo book: On many bulk carriers it is the chief mate's practice to keep the details of previous cargoes readily to hand and this procedure can be strongly recommended. Considerable time can be saved and efficiency can be increased by studying the record of previous similar cargoes, particularly if carried between the same loading and discharge ports. One method of keeping such records is for the chief mate to maintain a cargo book.

Into such a book the chief mate will enter the principal details of each cargo with disposition of cargo (stowage plan), detailed list of bunkers and other weights aboard, departure and arrival drafts, dock water density, draft limitations, description of loading and discharging procedures, amount of cargo on conveyor belt, suggested trimming quantities and holds which were used for trimming, requirements of stevedores, reliability of shore weights, availability and price of fresh water, arrangements for access, and so on.

The completion of such a record in the first day or two after the port visit will take no more than an hour or so. His notes will include any information which could make a repeat voyage easier, such as which side is put alongside, tugs and moorings used, stevedores' hours of work, telephone availability, and arrangements for garbage disposal. If a local port information book has been obtained that fact also should be recorded.

Once a ship has gone beyond the first few voyages such a book needs a contents page, listing voyage number, date, cargo carried, loading port and discharging port: it makes good sense to maintain a contents page from the start. By reference to this book any similar previous cargoes can quickly be identified and their details inspected.

Voyage records: Whilst on charter the ship will probably be required to complete voyage abstracts for the charterers. If the ship is on voyage charter, the owners may require the master to complete a pro-forma layday statement to enable them to check despatch or claim demurrage. Copies of these documents must be retained aboard ship.

Chain register-cargo gear register: The chain register is the register in which data concerning a ship's lifting gear must be recorded. The term 'lifting gear' includes derricks and cranes for the handling of stores, and also lifting gear used in the engineroom, and it is important that all such items of equipment should be properly tested, certified, marked and maintained.

The greatest practical importance of the chain register for a geared bulk carrier is as a register of all items of cargo-handling equipment. Such items, whether derricks or cranes, are used by stevedores for the loading and discharge of the cargo. Stevedores will expect to find that the equipment works efficiently and safely, and will, with good reason, complain about any defect in the equipment they are required to use. If they have any doubts about the condition of the equipment they will demand to inspect the chain register and it is vital that the register be kept fully and correctly up-to-date. In countries such as Australia and Canada union inspectors are likely to carry out spot checks aboard a ship to ensure that all the gear is safe, and also to verify that all items of gear are clearly marked and that test certificates can be readily located. Failure to have the chain register kept properly up-to-date can result in stoppage of work until matters have been put right, and the vessel will be put off hire in these circumstances.

There are two reasons for maintaining a chain register: it may be a requirement of the country with which the ship is registered and it may be a requirement of the country in which the ship is loading or discharging cargo. In theory a chain register issued in the form approved by any national authority or classification society will be acceptable in all countries which call for a register. In practice this is generally true, particularly when the ship is well maintained, but there are exceptions.

The chain register of one country is not always accepted at a local level in another country and some ship operators put aboard their ships chain registers from a number of the countries where difficulties are experienced in the ports. Thus a Liberian-registered ship may carry chain registers from Lloyd's Register and from the Government of Canada, Australia, New Zealand and India. Each country has its own requirements regarding frequency of inspection and these requirements differ one from another.

Some national administrations accept the chief officer as a 'competent person' whose signature for annual surveys is acceptable, but other countries such as India and Pakistan will accept a chief officer's signature only when he has a certificate issued by the government of the State whose flag the ship flies, stating that he has the authority to sign. The Panamanian register requires all surveys to be verified by a classification society surveyor.

Any chain register which the ship carries must be properly kept up to date. Before the register can be signed the following requirements must be satisfied.

- Every item of cargo gear must be of sufficient safe working load (SWL), and suitable design.

- Every item of cargo gear must be marked with a unique identifying number.
- There must be a certificate, in an approved form, for each item of cargo gear, identified by its unique number.
- A system must exist to produce the certificate for any item of cargo gear promptly.
- Every item of cargo gear must be in sound condition, and well maintained.
- Thorough inspections of the cargo gear must be carried out at the required intervals (annually for most authorities, but three-monthly for Australia).

When the inspections have been carried out the register must be signed in the appropriate places. Registers are normally divided into four parts to deal with four different categories of equipment. Careful study of the register will be required to identify where signatures are needed.

Quadrennial examinations of lifting gear are carried out by competent persons such as surveyors from classification societies and foreman from marine engineering works, who will sign the chain register upon completion of their work. If several chain registers are carried, the surveyor must be asked to sign all of them.

It will be apparent from the foregoing that national and local regulations for chain registers are varied, and their implementation is somewhat arbitrary. It may never be possible to comply with every requirement of every authority, but a ship aboard which the equipment is carefully maintained and renewed, properly marked and documented in accordance with the requirements of the flag State, and readily identified, will have done all that can reasonably be expected.

Reference books required aboard bulk carriers

A list of reference books which are recommended specifically for carriage aboard bulk carriers is to be found at the end of this chapter.

The IMO Code of Safe Practice for Bulk Cargoes[22]: The *BC Code* is a carefully researched guide to the safe carriage of solid bulk cargoes. It should be consulted whenever unfamiliar cargoes or circumstances are encountered, and it should be read and reread regularly by ships' officers to ensure that they remain familiar with the principles of carrying solid bulk cargoes safely.

The primary aim of the *BC Code* is to promote the safe stowage and shipment of bulk cargoes by highlighting the dangers associated with the shipment of certain types of bulk cargoes and giving guidance on the procedures to be adopted when the shipment of bulk cargoes is proposed. The *BC Code* also lists typical materials currently shipped in bulk together with advice on their properties and handling, and describes test procedures to be employed to determine various characteristics of the bulk cargo materials.

Topics discussed include cargo distribution with reference to stress and stability, loading and unloading, the safety of personnel, assessment of the acceptability of cargoes for shipment, trimming procedures, methods of determining the angle of repose and materials possessing chemical hazards. Extensive appendices list the properties of many dry bulk cargoes and describe relevant laboratory test procedures. Emergency schedules are set out for those materials possessing chemical hazards, and a code of safe procedures for entering enclosed compartments is provided.

The *BC Code* is a useful source of stowage factors and properties of bulk cargoes although recent editions, unlike some earlier ones, no longer contain this information for cargoes which may liquefy, apparently because the data are now considered too varied and unreliable.

The International Maritime Dangerous Goods (IMDG) Code[82]: This *Code* lists the properties of a considerable number of hazardous cargoes and states the conditions under which they can be safety carried. The *Code* must be consulted and its recommendations for packaging, handling, stowage and carriage must be followed when they apply to cargoes carried. Latest corrections should be added when published and the record of corrections should be updated when they are made.

Thomas' Stowage[49]: A useful guide to the properties of dry breakbulk and bulk cargoes, and to their carriage.

Publications Recommended for Particular Trades:

- *IMO Code for Carriage of Timber Deck Cargoes"*--for ships carrying timber deck cargoes.
- *IMO Recommendations for the Safe Use of Pesticides in Ships*[67]–for ships with infested cargoes undergoing fumigation.
- *IMO International Grain Code*[ie]*-for* ships carrying grain.
- *IMO Code of Cargo Stowage & Securing*[96]–for stowage of containers, portable tanks, portable receptacles, wheel based cargoes, heavy items, steel coils, heavy metal products, anchor chains, bulk metal scrap, intermediate containers, logs and unit loads.
- *Australian Manual of Safe Loading, Ocean Transport & Discharge Practices for Dry Bulk Commodities*[87]*-for* ships loading bulk cargoes in Australian ports.
- *Bulk Carrier Practice* (The Nautical Institute): This is a volume written to provide detailed and specific advice on the practical shipboard operation of bulk carriers.

The approved stability booklet and loading manual for the ship, with data for grain and timber loading conditions if appropriate: This information is, of course, essential for the planning of the safe loading and carriage of bulk cargoes. It is usual for the master to have in his care a clean copy of the information, endorsed with the stamp of approval of the national authority, for production to the authorities. The chief mate has a working copy for the day-to-day completion of cargo calculations.

Occasionally there is aboard ship only a single copy of the data, and that in poor condition. Such a situation is not acceptable. It is normally possible to obtain a duplicate copy from the owners, who can be expected to hold in their office a copy which can be reproduced. Failing that the builders can for a fee normally provide a replacement copy. If the dog-eared copy is the only one marked with the Stamp of Approval of the National Authority it should, of course, be retained to be produced to the authorities when required.

It is also essential that the stability information possesses text written in the language of the ship's officers or in one with which they are thoroughly familiar. Sections such as *General Principles* and *Special Notes Regarding the Stability and Loading of the Ship* must be properly understood.

Tank calibration tables: These are tables which show for each of the ship's tanks the volume of liquid which corresponds to the sounding obtained. Calibrations are required for all ballast, fresh water, engine water, fuel oil and diesel oil tanks, and for ballast holds. These calibrations are normally calculated by the builders from the ship's drawings, in which case they may be marked 'as designed' or 'as built'. 'Enhanced drawing calibration' is a method of improving the accuracy of the calibrations. This is achieved by adjusting certain basic measurements taken from the ship's plans to correspond with the physical dimensions taken 'in tank'. A range of more accurate though more expensive methods of tank calibration is also available, but is unlikely to be used for the ballast tanks of bulkers.

The basic calibrations will only be correct for a single condition, usually with the ship even keel-i.e., untrimmed. Additional tables will provide corrections, or corrected values, for a trim of perhaps 1 metre and 2 metres by the stern. If the actual trim is a value other than the quoted values, it will be necessary to interpolate to obtain the exact volume of liquid in the tank and if no trim corrections are provided the corrections to apply must be calculated by geometry. These are calculations which can be quickly done with the assistance of a suitable computer programme, if provided.

The normal purpose of finding the volume of liquid in a tank is to discover its weight. If the weight is required, the volume obtained from the calibration tables must be multiplied by the density of the contents-fuel oil, diesel oil, ballast water or fresh water. (The use of calibration tables for the calculation of weights aboard ship is described in Chapter 13).

It is usual for the chief mate and the chief engineer both to have working copies of the tables, and a clean copy should be retained, perhaps by the master, so that replacement copies can be produced when the working copies become dirty and worn.

Ship's plans or drawings

If the ship's officers are to deal efficiently with the problems that they are likely to encounter during the lifetime of a ship, and particularly as she becomes older, they will require three sets of ship's plans, or drawings, with the master retaining a 'best' set, and chief mate and chief engineer each keeping a working set. If these plans are to be of maximum value, the labels and summaries which they contain should be written in the language of the ship's officers. It may be acceptable for them to be labelled in English if the officers have a sufficiently good command of English.

For efficient use the plans are best stored in an indexed filing system and folded as originally supplied, with their titles visible. It is useful to maintain a book in which the removal and return of plans is recorded to assist in the tracing of missing plans. Plans should be checked annually against the index and missing plans located or renewed.

Occasionally the vertical scale of a plan is different from the horizontal scale: this should be remembered if it is necessary to take measurements from a plan. A triangular scale rule which can be used to read dimensions at six different common plan scales is a useful item of equipment.

Framed copies of some of the most important plans are likely to be displayed upon bulkheads within the accommodation, either in alleyways or in offices or control rooms. They are likely to fade and become unreadable over a period of years and should be replaced when this happens. Copies of plans can often be supplied by the builders, even many years after the ship was built, though the price for this service may be high.

General arrangement plan: The general arrangement, or GA, plan (Fig. 1.3) is normally at a scale of 1:100 or 1:200 and shows a side elevation of the ship, accompanied by a plan view drawn for each deck which the ship contains. In addition it usually features a midship cross-section of the ship. It shows the ship's frame numbering (a system which provides a quick reference to the positions of structural items), and the locations of holds, tanks, storerooms, cabins, main items of machinery and equipment, and the positions and heights of masts, antennae and radar masts. It may provide a list of the ship's principal dimensions and particulars.

The GA plan is a useful source of general information about the ship and can be used for the measurement of distances such as the air draft, or the distance from the centre of No.4 hold to the bows, should these be required. It can also be a useful for identifying items to be included in a planned maintenance scheme for the ship.

Capacity plan: The capacity plan (Fig. 3.2) is designed to provide all the basic information necessary to plan and supervise the loading, carrying and discharge of cargo. It normally includes a side elevation of the ship, and plan views taken at upper deck and at tanktop level, and often transverse cross-sections in way of each cargo hold. Dimensions of holds and hatches are usually stated, as are maximum permitted tanktop, deck and hatchtop loadings, though for *Regina Oldendorff* this information is provided elsewhere.

The grain and bale capacities of each cargo compartment are stated in cubic metres and/or cubic feet. Grain capacity is the total internal volume of the cargo compartment and is so called because it is the space which could be occupied by a cargo of bulk grain if trimmed to fill all spaces within the compartment. Bale capacity, by contrast, allows for the fact that bulky cargo such as bales or steel products cannot be stowed against the ship's shell plating, bulkheads and deckheads because of the frames, stiffeners and beams which are attached to these surfaces at intervals. Bale capacity is grain capacity less the space contained between internal hold fittings. Capacities of the hatch coamings are often given separately from capacities of the holds.

REGINA OLDENDORFF - PUMPING PLAN
(Reduced to 1/16th its original size)

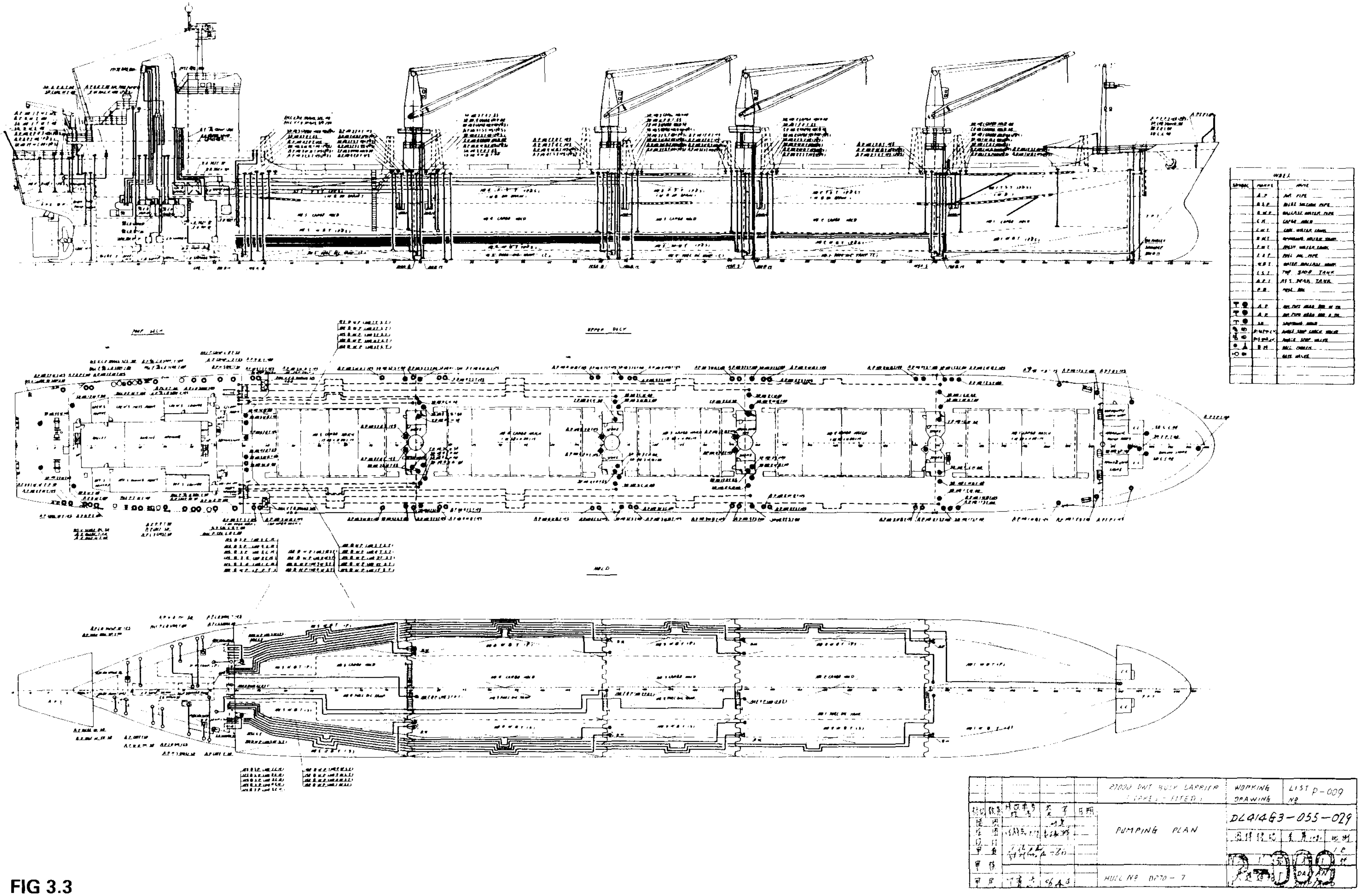


FIG 3.3

The capacity plan shows in tabular form the position of the vertical centre of gravity of each cargo compartment in height above the keel (KG), and of the longitudinal centre of gra\ity in distance measured from amidships (⊕G) as in this example, or from the after perpendicular.

The capacity and position of centre of gravity of every tank aboard the ship also appears on the capacity plan. The tonnages of the contents of the tank when filled, and when 97 per cent rilled, with the intended liquid are often stated too, and the specific gravities (SGs) used for ballast water, fresh water, heavy oil, diesel oil and lubricating oil arc quoted, these tonnages are sufficiently accurate for approximate calculations, but must be recalculated using the actual SGs and volumes when exact deadweight calculations are being carried out.

Details of any cargo handling equipment with which the ship is fitted are usually shown, with the safe working loads (SWLs) of cranes or derricks, lengths of booms and jibs, and maximum outreaches of the ship's gear beyond the ship's side.

The capacity plan normally includes a drawing of the ship's loadline and freeboard, and a statement of the draft and displacement which corresponds to each of the allotted seasonal lines. It also features a deadweight scale with columns for draft, deadweight, displacement and other items of the ship's hydrostatic data. The more elaborate scales contain columns for both salt water and fresh water. From the scale it is possible to read off approximate values for deadweight, for tonnes per centimetre immersion (TPC), or for moment to trim a centimetre (MTC). More accurate values can be obtained from the ship's stability tables, which should be used for all accurate calculations and surveys.

Trimming tables may be included in the capacity plan to show the amount that the ship will trim if 100 tonnes (or some other unit weight) is loaded at the point shown. These can be useful for quick approximate calculations, but more useful and accurate results can be obtained from standard calculations.

Pumping plan: The pumping of ballast and of bilges will normally be done by the duty deck officer who will himself operate the appropriate controls to set the valves and start the pump, or who will instruct a pumpman to carry out these operations. These are the pumping matters described in this volume.

The pumping plan for the *Regina Oldendorff* (Fig. 3.3) shows the layout of the ship's bilge, ballast and bunker pumping arrangements and of the air and sounding pipes for the bilge, ballast and bunker compartments. Marked on the ship's profile in the pumping plan are the positions of all the suctions in double bottom, topside and peak tanks and in hold bilges, and the pipelines connecting them with the pumps in the engine room. The upper deck plan view shows the locations of all the airpipe outlets and the sounding pipe caps, as well as the positions of the ballast lines connecting the topside tanks to the engineroom, whilst the hold plan view shows the layout of piping and the positions of suctions in the double bottom tanks.

Separate plans deal with the lines, valves and pumps serving machinery spaces and domestic services: the plan of the bilge and ballast pumping arrangements in the engineroom (Fig. 3.4) shows the positions of the pumps, the valves and the pipelines. It is often useful when difficulties with ballast are met, or when an unusual ballasting or deballasting operation is planned. For example, is it possible to change trim quickly by pumping water direct from afterpeak to forepeak? The answer can be obtained from the plan.

The pumping plan can also assist in the study of ballasting or deballasting problems. Why does No.4 port double bottom tank fill when the forepeak is being filled? If the plan shows that the forepeak filling line passes through No.4 port double bottom tank it is likely that the filling line is holed in Xo.4 double bottom tank.

Sounding and airpipe plan: For the *Regina Oldendorff* the positions of soundings and airpipes are shown on the pumping plan (Fig. 3.3) but this information is often provided on a separate plan which shows the position of every sounding pipe and airpipe, and is useful for ensuring that all spaces can be regularly sounded. It is consulted when problems are experienced with a sounding and investigations have to be made.

It is not unusual for the sounding pipe for No.2 hold starboard bilge, say, to run down the forward bulkhead of Xo.3 hold. It is useful to discover before leaving the accommodation that the search must be in No.3 hold or No.3 double-bottom tank, not \o.2. It is also a loadline requirement (and good seamanship) to ensure that all the labels and markings on individual airpipes are correct, and the plan will assist in this process.

Cargo ventilation plan: This shows the locations of hold ventilator cowls, of ventilator trunks and of ventilator flaps for opening or closing the trunks. It shows whether air can be delivered through grilles at the bottom of the hold or only at the top. If ventilator fans are fitted, their positions are shown and the capacity of each should be stated. The plan should show the number of air changes per hour which can be achieved in each hold, when empty, if the fans are running.

The cargo ventilation plan should be consulted when the hold ventilation system is being tested and maintained and when a cargo which requires ventilation is to be carried. It is also of the greatest importance should a fire develop in the cargo. In these circumstances it will be necessary to ensure that all hold ventilation is sealed.

Construction plans: The ship's construction plans provide details of the steelwork used in the construction of the ship and are useful when damage has to be described or repairs must be specified. The dimensions and plate thicknesses are shown for decks and internal members such as frames, floors, beams and brackets.

Midship section plan: The midship section plan shows the ship's transverse cross-section at her midlength. The position and dimensions of the bilge keel, and the shape of the turn of the bilge can be seen in this plan. This plan may form part of the docking plan.

The docking plan: The docking plan (Fig. 3.5) is of value when the ship is to enter a drydock. It shows the

REGINA OLDENDORFF - PUMPING DIAGRAM
For bilge, ballast, fire extinguishing and sludge pumping arrangements in the Engine Room

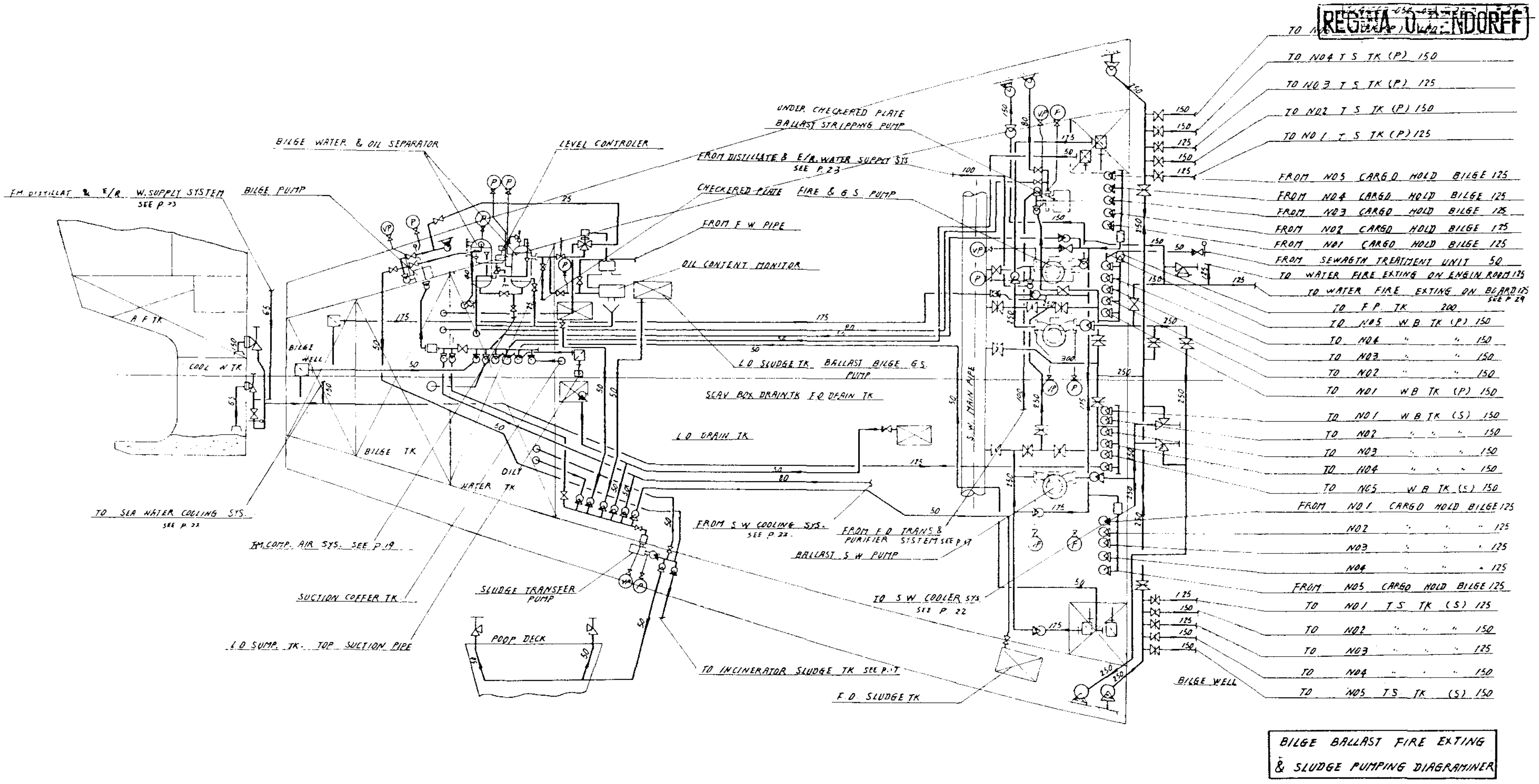


FIG 3.4

ship's bodyplan, the positions of the overboard discharges and the drainplugs for the double-bottom tanks, thus providing the information and measurements required by the drydock operators to enable them to place the blocks and sidebeds correctly. Locations of the double-bottom manholes, the echo-sounder and the log probe are also likely to be shown. The docking plan is a useful alternative to the general arrangement plan and the capacity plan when measurements are required.

Shell expansion plan: The shell expansion plan shows the entire shell plating from one side of the ship. A portion of the plan for the *Regina Oldendorff* taken from the bow area (Fig. 3.6) is typical, and shows individual shell plates with the positions of the welds which join them to adjacent plates. The position and the reference number of each vertical frame is shown, the frames being numbered in sequence from the after perpendicular, so that No. 230 is reached near the bows. Strakes of plating are given letters, circled on the plan, with 'A' being the strake next to the keel plate. Although the lettering is consecutive the number of plates is reduced at the ends of the ship, and plates B-F do not appear in the bow section. The numbers (such as '17' and '22') show the plate thickness in millimetres. The positions of other features attached to the shell plating, such as bilge keels, hawse pipes, frames, stringers, bulkheads, engineroom intakes and discharges, and fairleads in the bulwarks, are shown.

Any position on the shell plating can be identified by specifying port or starboard side, with the appropriate letter for the strake of plating and then stating the nearest frame numbers. This system will be used when describing damage which has occurred or when speciying a point where repairs are to be made. The position of damage might be described as follows: *Circular indentation, diameter 1.5 metres, with depth of 20 cm at centre, located starboard side, in plate G, frames 105/106.*

Other plans: Plans such as bulkhead plans and tanktop plans are useful when damage, repairs or modifications to these features are contemplated, and vessels which are equipped like the *Regina Oldendorff* with lashing points (securing eye plates) in the hold have plans to show their positions.

Fire protection plans: The provision of fire protection systems in cargo spaces is usually subcontracted to specialist fire protection companies who produce their own plans and booklets to describe the system. Such systems, which normally protect the machinery spaces as well as the cargo compartments, typically consist of provision for CO_2 smothering. From a bottle room pipes lead to every cargo and machinery space. If a fire occurs the appropriate quantity of CO_2 gas can by decision of the officer in charge be injected into the compartment which contains the fire. The same pipework may also be routinely used to continuously extract samples of air from each compartment and deliver them to a central point such as the navigating bridge. Here they pass across a photo-electric cell which detects smoke and activates an alarm. (The system is described in Chapter 6.)

Full plans of the system should be available and may need to be consulted when damage is being repaired or when the system is being tested. In addition, instructions for operating the system in event of fire will be posted in the CO_2 bottle room and in one or two other prominent positions such as the bridge.

Safety equipment plan: Copies of the ship's safety equipment plan will be located in several prominent positions throughout the accommodation. On a longitudinal profile of the ship, supplemented by plan views of every deck, the position of every item of lifesaving and firefighting equipment will be shown. The plan will also list each item of equipment with brief details of sizes and types of hoses, hydrants, fire extinguishers, fire doors, firemen's outfits, breathing apparatus, safety lockers, lifebuoys and attachments, lifeboats, liferafts, ladders, emergency lighting, remote machinery stops, and so on. Colour coding of these plans makes them easier to read, and the symbols used must be internationally recognised. The plan may be divided into two, with a fire control plan and an arrangement of lifesaving equipment.

Sources

15. Wallace, R. I., BA, FInst Pet, MCMS, MNI, Tank Calibration'. *Work of the Nautical Surveyor.* The Nautical Institute. 1989.

189. *The Master's Role in Collecting Evidence.* The Nautical Institute. 1989.

REGINA OLDENDORFF - DOCKING PLAN
(Extracts from plan, reduced to 1/9th their original size)

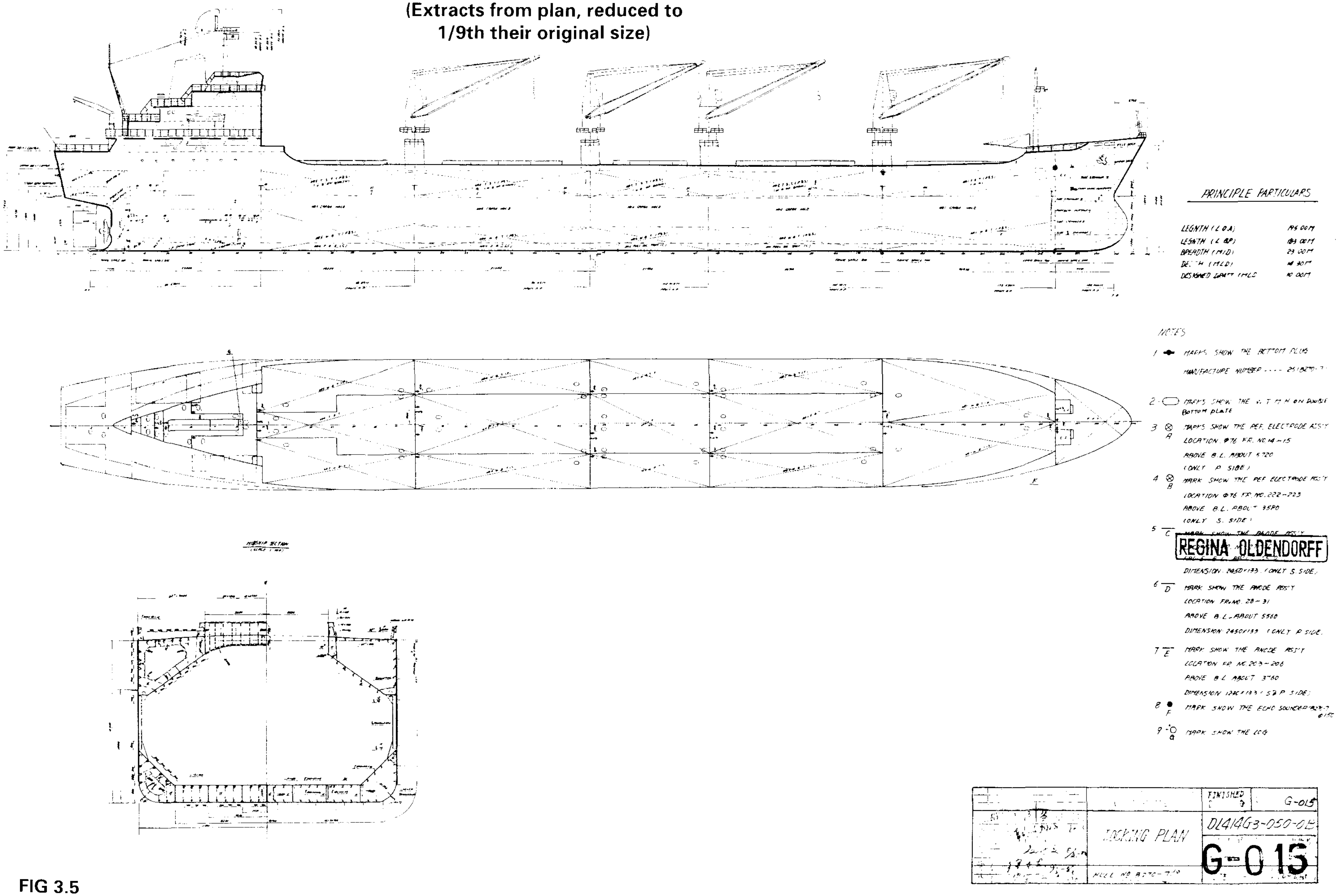


FIG 3.5

CHECKLIST-Records which should be maintained aboard bulk carriers

Following deck log book entries

- ☐ Routine navigational, weather, sea state and ship's performance data.
- ☐ Details of heaving-to, or action taken to avoid a tropical storm.
- ☐ Dew point readings of cargo spaces and on deck.
- ☐ Ventilation of holds–times of starting and stopping, reason for stopping, ventilators used, type of ventilation, direction of ventilation, speed of fans, hygrometer readings.
- ☐ Water, rainfall and spray over decks or hatches.
- ☐ Hold and hatch cover inspections–dates and times, names of person making inspection, nature of inspection, and findings.
- ☐ Temperatures, and methane and O_2 meter readings, of cargo.
- ☐ pH of bilge water.
- ☐ Pumping of bilge water–time, tonnage and origin.
- ☐ Soundings–full set daily, giving actual soundings, not *MT*.
- ☐ Testing of cargo care systems such as hold bilge pumping system, hold ventilation fans, hold CO_2 injection systems, testing of hatch cover watertightness.
- ☐ Inspection and tightening of lashings on cargo.
- ☐ Changing of ship's ballast, to comply with pollution regulations, or for purposes of draft and trim.
- ☐ Details of any in-transit fumigation.

Following deck log or cargo log entries

- ☐ Surveys undertaken, with times, result and identity of surveyor.
- ☐ Protests made by the ship, and to the ship.
- ☐ Details of any fumigation undertaken.
- ☐ Starts, stoppages and completions of cargo work.
- ☐ Transfers of cargo-handling equipment.
- ☐ Tanks ballasted and deballasted.
- ☐ Ballast valves opened and shut.
- ☐ Starts and stops of ballasting, and ballast pump readings.
- ☐ Soundings obtained.
- ☐ Cargo tonnages calculated or advised.
- ☐ Draft readings at completion of each pour during the loading, and at least twice daily during discharge.
- ☐ Details of shifting ship.
- ☐ Times of bunkering, and quantities taken.
- ☐ Weather observations.

Cargo documents

- ☐ Copies of all cargo documents issued or received.
- ☐ Authorisation to charterers or their agents to sign Bs/L.

Trim, stability and stress calculations

- ☐ Values used in calculations.
- ☐ Results obtained.
- ☐ Full details of departure condition.
- ☐ Copy of each cargo operations control form issued.
- ☐ Ship's own draft survey calculations.
- ☐ Draft survey calculations by independent surveyors, and results obtained.

Damage records

- ☐ When, where and how damage to ship or cargo occurred.
- ☐ Detailed description of damage sustained.

REGINA OLDENDORFF - SHELL EXPANSION
(Portion of plan, reduced to 1/4 its original size)

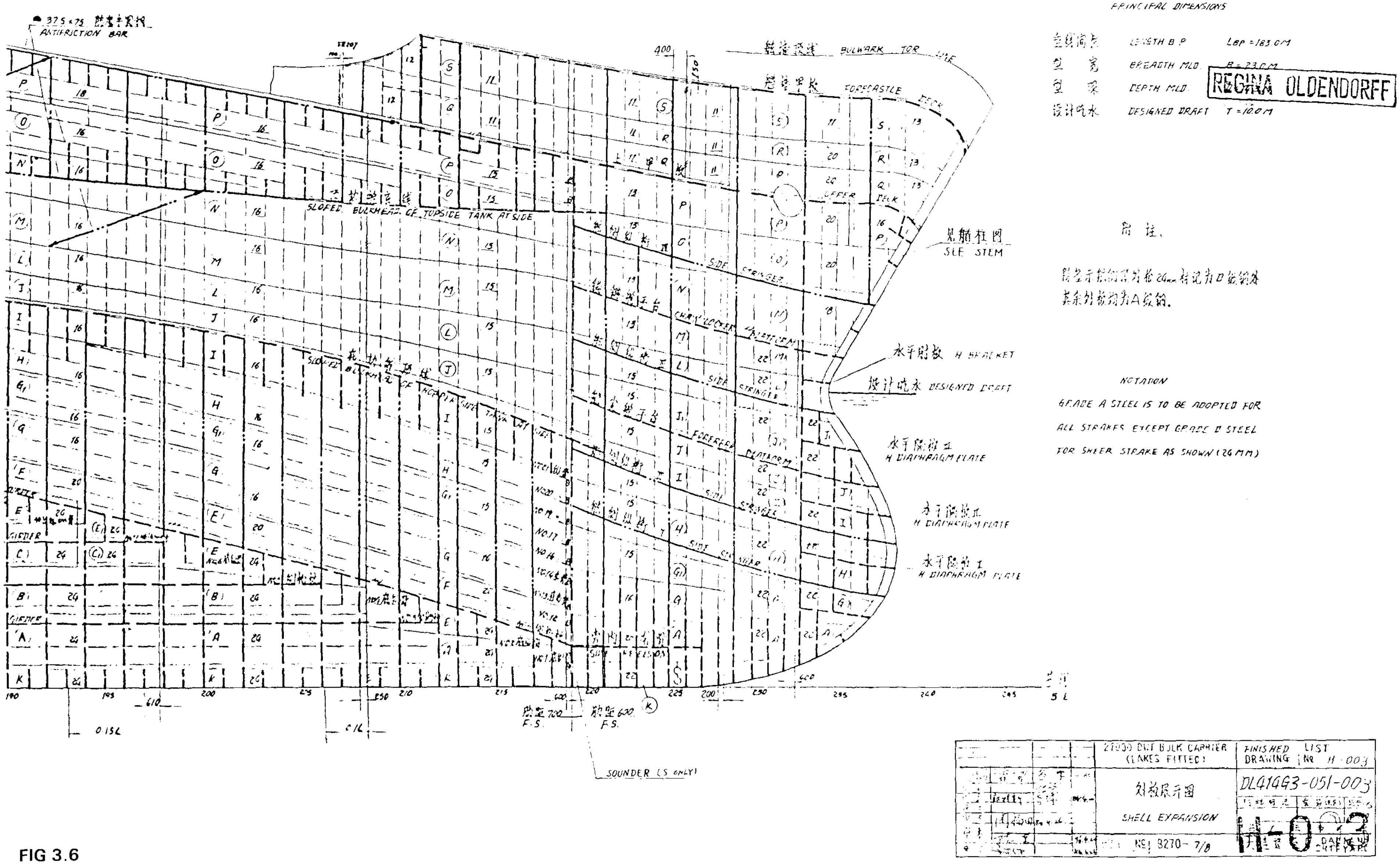


FIG 3.6

Cargo book

Principal details of each cargo carried, with notes.

Voyage records

- ☐ Voyage abstracts.
- ☐ Proforma layday statement if required by owner.

Chain register-cargo gear register

- ☐ Records of quadrennial inspections, and of thorough examinations of cargo gear, as required by regulations.
- ☐ Full set of certificates for the ship's cargo gear.

Reference books required aboard bulk carriers

- ☐ *Code of Safe Practice for Solid Bulk Cargoes*[22].
- ☐ *The International Maritime Dangerous Goods Code*[82].
- ☐ *Thomas' Stowage*[49].
- ☐ *Bulk Carrier Practice* (The Nautical Institute).
- ☐ Stability & loading manual for the ship.
  Provided by shipbuilder. Approved by National Authority.
- ☐ Ship's calibration tables.
  Provided by shipbuilder.
- ☐ Ship's plans.
  Provided by shipbuilder.

The following reference books when required.

- ☐ *Code of Carriage for Timber Deck Cargoes*[18].
- ☐ *Safe Use of Pesticides in Ships*[67].
- ☐ *International Grain Code*[46].
- ☐ *Australian Manual of Safe Loading*[87].
- ☐ *Code of Cargo Stowage & Securing*[96].

PARTS OF STEEL HATCH COVERS

CROSS JOINT CLEAT & SECTION THROUGH CROSS JOINT

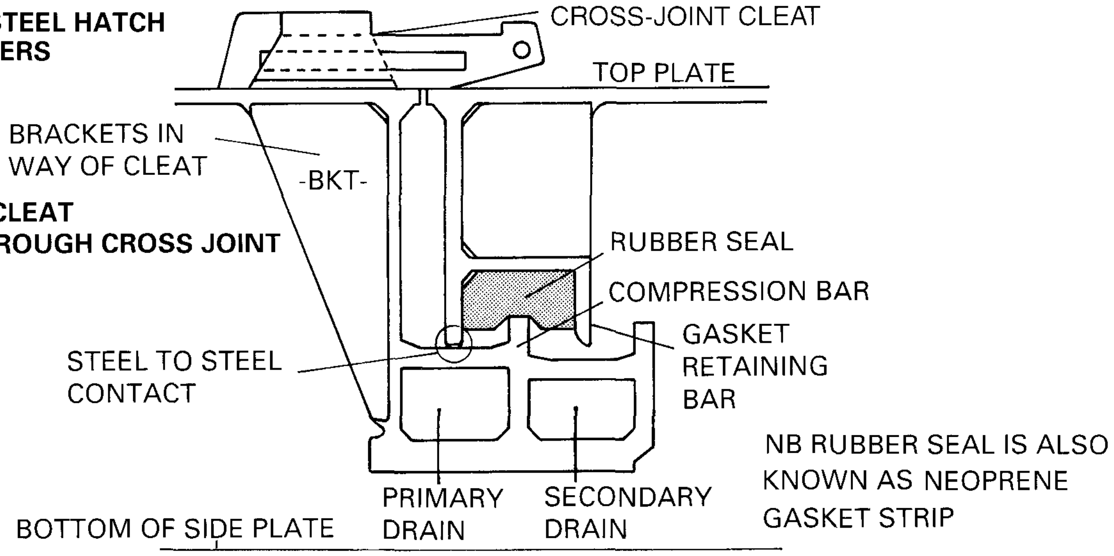


FIG 4.1

QUICK ACTING CLEATS/ COAMING REST BARS

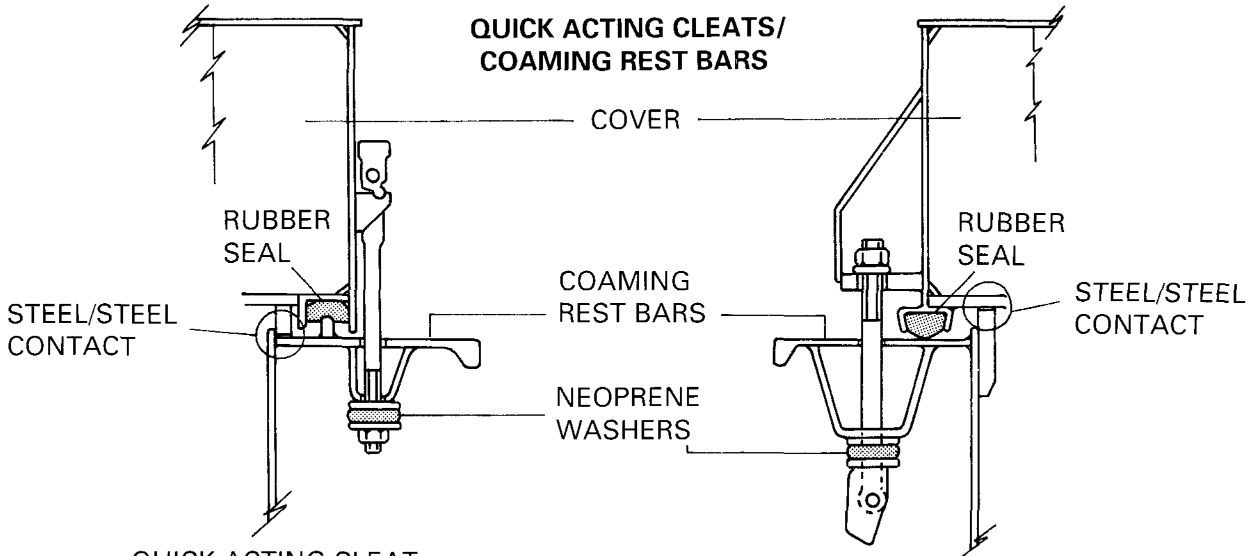
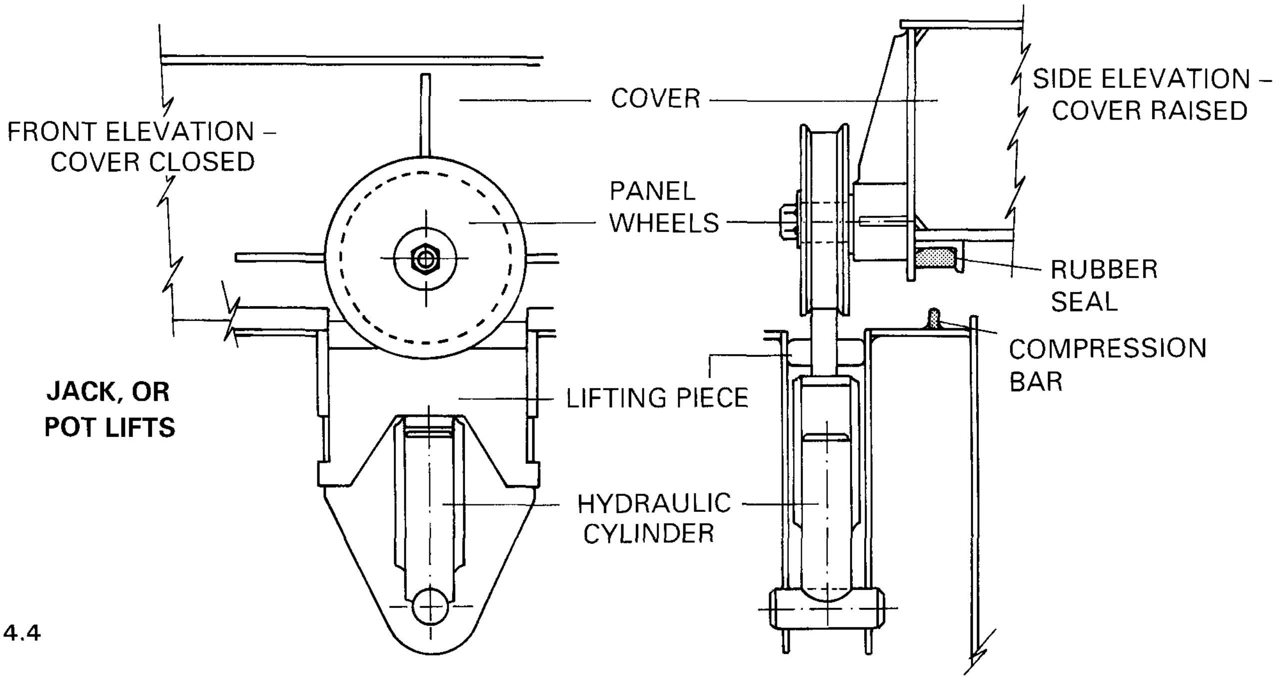


FIG 4.2 QUICK ACTING CLEAT– TOPSIDE ACTUATION

FIG 4.3 QUICK ACTING CLEAT– ACTUATION BELOW COAMING



JACK, OR POT LIFTS

FIG 4.4

FIGS 4.1—4.20 AND 4.23 REPRODUCED BY COURTESY OF MACGREGOR-NAVIRE (GBR) LTD

CHAPTER 4

MAINTENANCE AND CARE OF HATCH COVERS

Development, hatchcover types, general description and design, surveys, testing for watertightness, maintenance procedures, some defects, emergency opening and closing, hatch leakage-first aid

Development of steel hatch covers

THE DESIGN of steel hatch covers has evolved to meet new requirements since they were first introduced in the 1920s. In the 1950s hatch panel size and numbers had so increased that the ships' cargo gear, if fitted, could no longer provide the power required to open and close the hatch covers. The need for sell-propelled or self-activated systems was met at that time by the introduction of hatch hydraulics. These in turn were superseded on geared bulk carriers by direct pull hatch covers where savings could be made by avoiding the use of hydraulics.

The last 20 years have seen the development of a variety of hatch cover types for different situations. These include folding, rolling, piggy-back, stacking, lift-away and coiling types.

Whilst hatch covers were evolving, the design of the ships to which thev were fitted was also developing. Hatch openings were being increased in si/e to occupy a much larger part of the deck area, which created enormous problems with twisting, racking and strength moments of hatch covers and, of course, created problems of watertightness. At the same time, developments in their design and construction resulted in vessels with hulls which arc today much more flexible than was the case 30 or 40 years ago.

A modern set of hatch covers is likely to be of large dimensions, and must possess great strength to withstand high deck loadings from deck cargo carried and seas shipped. To meet these requirements they must be stiff and inflexible. The challenge for the designer is to achieve a watertight fit between such hatch covers, and the 'flexible "U" shaped trough' which is the hull of the modern bulk carrier. It is likely that the future will see the increased use of lighter alloy structures, and of plastics, in the design and outfitting of hatch covers.

Hatch cover types

Single-pull (Figs. 4. 12-13): Single-pull covers are sets of panels linked together by chains or rods at the coaming sides. Single-pull covers stow vertically at the hatch end or ends. The}[1] can be designed to be manoeuvred by wire led from crane or winch, or can be driven by chains powered by motors situated at the hatch end, or set into one of the hatch panels. Before they can be moved the panels must be raised, and the svstem to raise and lower them can be manual or automatic. Clearing is the process of clamping hatch panels firmly to the coaming and to each other to limit the movement, and dealing, too, can be manual or automatic. Forty percent of the world fleet of dry-cargo vessels was fitted with single-pull steel hatch covers in 1991. Raising of the covers is by hvdraulic means aboard most larger and newer vessels.

Folding (Fig. 4.14-16): The basic two-panel folding system, as fitted aboard the *Regina Oldendoiff,* has hinges between the two panels, and hinges at the hatch end. One pair of panels folds to the fore end of the hatch and the other to the after end. More complex systems have three or four folding panels in a set. The system can be wire operated when cranes or derricks are available or can be: hydraulically powered by external or internal hydraulic cylinders, dealing can be manual or automatic and jacks to raise the panels are not needed.

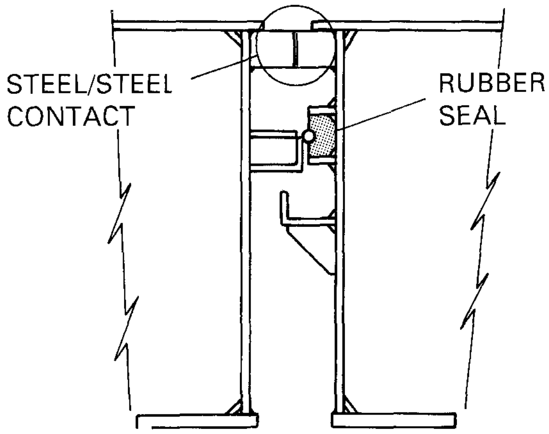
Rolling (Fig. 4. 17): Side rolling covers roll transversely and end rolling covers roll longitudinally, both types rolling on rails mounted on and extended from the hatch coamings. Such covers are either single panel or two panel per hatch, in the latter case one panel normally rolls to each side. The panels are manoeuvred by positive drives of the rack and pinion, rack, pinion and wire, or chain drive type, and the panels are raised and lowered hydraulically, by jacks known as 'pot lifts'. This system is widely used on larger bulkers, including Panamax, Cape-sized, OBOs and ore/oil carriers.

Piggy-back (Fig. 4.18): The piggy-back svstem involves the stowage of one hatch panel over another whilst the latter is in place covering a hold, or part of a hold. An advantage of the system is that no deck space is required for the stowage of hatch panels, making it particularly suitable for open bulk carriers and conbulkers. With this type of hatch cover a number of alternative combinations of holds can be worked together.

For the piggy-back svstem one panel in each pair (the dumb panel) can be jacked up to permit the other (the motorised panel) to be rolled into position below it, where the upper panel is lowered onto it. The two panels can remain in the initial position, or can then be moved as a single unit. Piggy-back covers can be fitted as side rolling or end rolling, and the opening, closing and dealing systems are normally fully automated. A variety of electric and hydraulic systems is available for the main drive of the covers.

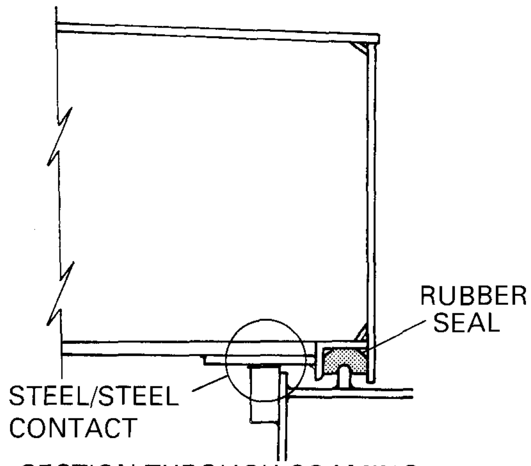
Stacking (Fig. 4.19): The stacking system is a development of the piggy-back system, with a number of panels being stowed and moved in a single stack. Initial stowage may be at the hatch end within the: hatch, or alternatively off the hatch end, leaving the full hatch length clear. The stacking system is particularly suited to long and wide wcatherdcck hatches such as are found on mini-bulkers with a single hold. Stacking weatherdeck hatch covers are usually all hvdraulic in operation, the panels moving to stowage or closure in a specific sequence, powered by means of an endless chaindrive mechanism.

Lift-away: Lift-away hatch panels, otherwise known



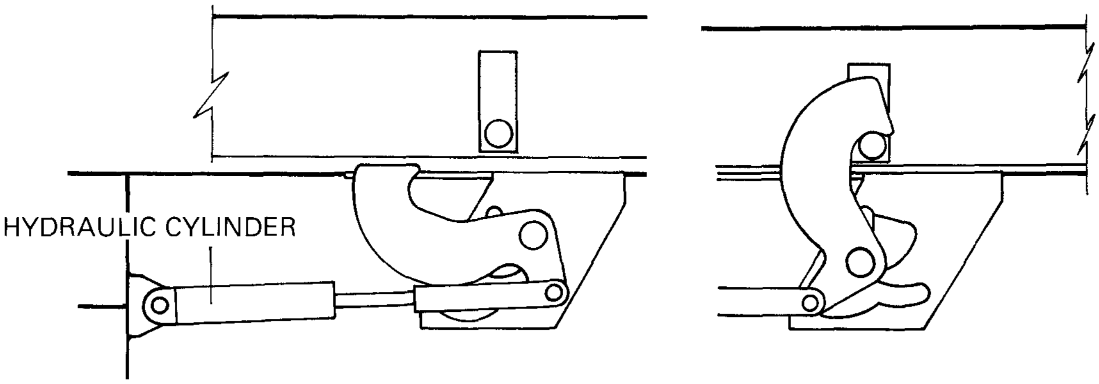
SECTION THROUGH CROSS JOINT

FIG 4.5



SECTION THROUGH COAMING SIDE AND/OR END

FIG 4.6



HYDRAULICALLY OPERATED HOOK CLEAT -

(A) PANEL RAISED

(B) PANEL CLEATED

FIG 4.7

SEALING ARRANGEMENTS AT COAMING OF SINGLE PULL HATCH COVERS

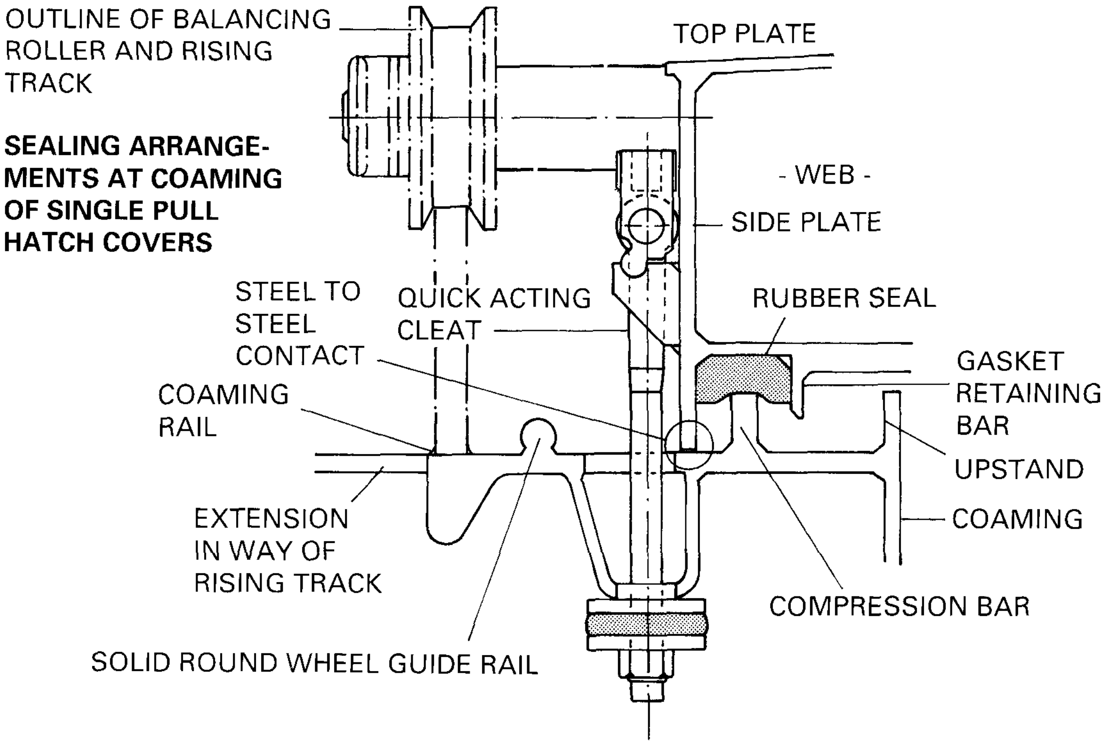


FIG 4.8

as pontoons, are completely removed for stowage on deck or ashore by the use of ship's or shore cargo handling equipment. This type of hatch cover is widely found on container vessels but is unlikely to be fitted to bulk carriers, except as part of a retractable 'tweendeck system.

Coiling (Fig. 4.20): Coiling hatch covers have as principal characteristics the fact that they are, when closed, continuous sheets which, being flexible, can roll or coil into stowage around a drum. Their operation is automatic, they require little stowage space, vet they leave the entire hatch opening exposed.

Coiling hatch covers such as the MacGregor-Navire Rolltite covers are load-bearing covers comprising a number of panels of varying length permanently connected by a hinge system and incorporating the necessary seals. They are controlled by push button and are self-cleating. It is claimed that the maintenance requirement is minimal. Ships fitted with this system included three 18,000-dwt coal carriers which were operated by the UK's Central Electricity Generating Board.

General description and design of hatch covers

Hatch covers in sound condition and properly maintained are required by a vessel's classification society, and by the authority which assigns her loadline. Amongst the factors which decide a vessel's freeboard are the type of hatch covers and the securing arrangements.

Self-closing hatch covers 'of steel or other material fitted with gaskets and clamping devices' are nowadays fitted to almost all bulk carriers. Whilst they may be made by different manufacturers and to a variety of designs, the principles of their construction are the same. The hatch opening is closed by several steel panels which rest horizontally across the hatchway. Each panel will consist, of an upper surface constructed of steel plate, reinforced and supported on the underside by steel beams or stiffeners. The panel may be of open construction, or may be a sealed unit closed on its underside by plating similar to that on its upper sides, and treated inside with a rust inhibitor.

This double-skinned construction reduces the need for cleaning and maintenance, allows for reduced scantlings and panel depth, provides better insulation, and thus reduces condensation within the hold. However, a temperature differential can arise between the outer and inner skins which will impose additional loadings on the securing devices, and may give rise to problems in OBOs. The weight of a single hatch panel is likely to be 4-5 tonnes on the smallest vessel, increasing to over 100 tonnes on the largest vessels.

When the hatch is opened the panels will be moved to stowage positions at one or both hatch ends, or at the hatch sides, or over other hatch panels. There they may be placed or stacked vertically or horizontally in a variety of ingenious ways, depending upon the design fitted.

A ship at sea in a seaway moves and flexes. Different conditions of loading which cause the vessel to hog or to sag also lead to surprisingly large changes in the si/e and shape of the hatch opening. An 80 mm fluctuation in the size of the hatch opening has, for example, been measured in a 3,000-dwt single-hatch coaster. As a consequence of the rigidity of the hatch covers and the flexibility of the ship's hull, rigid connections between hatch covers and hatch coaming are impractical, and elastic joints are necessary. Such a joint is achieved in manv vessels by a steel compression bar which projects above the coaming and which bears against a continuous neoprene ('rubber') gasket strip set into the hatch panel (Fig. 4.8). Of more recent design is an alternative system in which special sliding seals act directly upon the coaming rest bar and are free to move across the rest bar in response to fluctuations in the hatch dimensions (Fig. 4.3).

The cross-joint between adjacent hatch panels is made watertight in a similar manner, the compression bar attached to one panel bearing on the gasket set into the adjoining panel (Figs. 4.1 and 5). For folding hatches the cross-joint is sealed in a similar manner (Fig. 4.9).

The hatch panels are held in position by cleats of varying design. Because of the need for an elastic joint between adjoining panels, and between panels and coaming, the purpose of the cleats is to restrict the movement of the hatch panels when the ship is rolling or pitching in heavy seas and not, as might be thought, to achieve watertightness by physical compression of the gaskets. Watertightness is maintained by keeping the gasket in contact with the compression bar, helped by the elasticity of the gasket and the cleat washer. This is achieved by ensuring that all the component parts of the hatch covers are undamaged, and are properly installed and adjusted. The responsibilities of ship's personnel in this matter are most important.

Survey of hatch cover arrangements

It is a requirement of the Load Line Convention 1966 that hatch covers and hatch coamings are surveyed annually. These surveys, which cover much the same ground as the annual and special survey of the classification society, are normally undertaken by the same surveyor at the same time as the class surveys. The International Association of Classification Societies has drawn up a unified requirement"' for these surveys and specifies that annual surveys for mechanically-operated steel covers shall consist of the following.

1. General: Checking that no significant changes have been made to the hatch covers, hatch coamings and their securing and sealing devices since the last survey.

2. Hatch covers and coamings: Checking the satisfactory condition of hatch coamings, hatch covers, tightness devices oflongitudinal, transverse and intermediate cross-junctions (gaskets, gasket lips, compression bars, drainage channels), clamping devices, retaining bars, dealing, chain or rope pulleys, guides, guide rails, track wheels, stoppers, etc.

Special surveys shall, as a minimum, consist of the following.

- A general inspection with the extent of the annual survey as stated above and, in addition, random checking of the satisfactory operation of mechanicallv-operated hatch covers, stowage and securing in open condition, proper fit, locking and efficiency of sealing in closed condition.
- Checking the effectiveness of sealing arrangements of all hatch covers bv hose testing or equivalent.

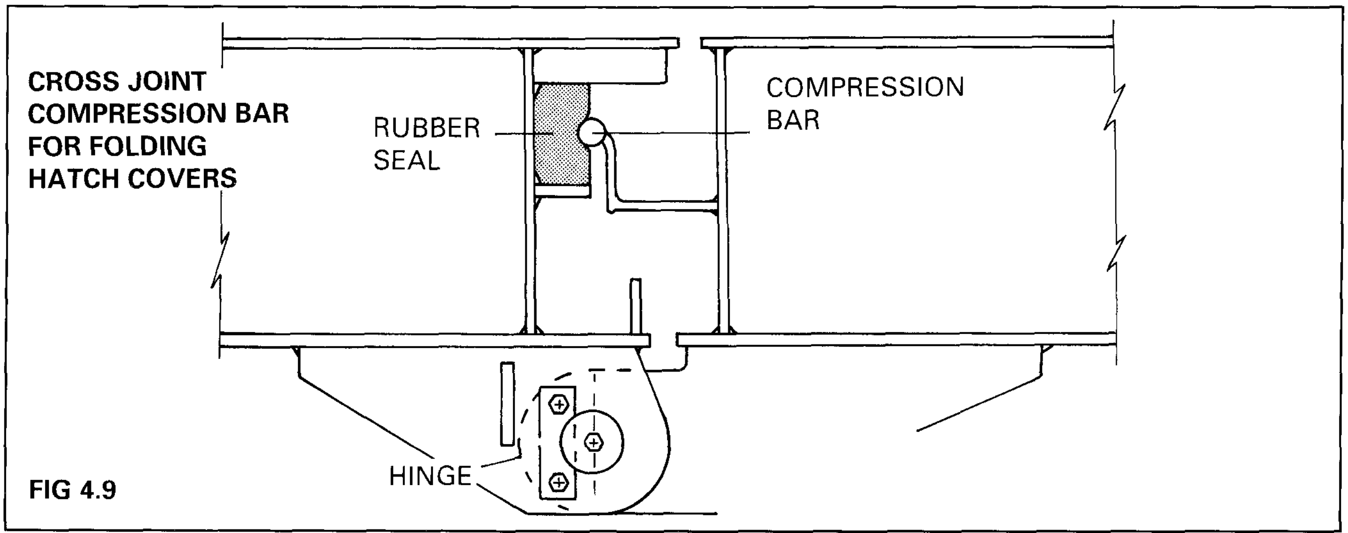


FIG 4.9

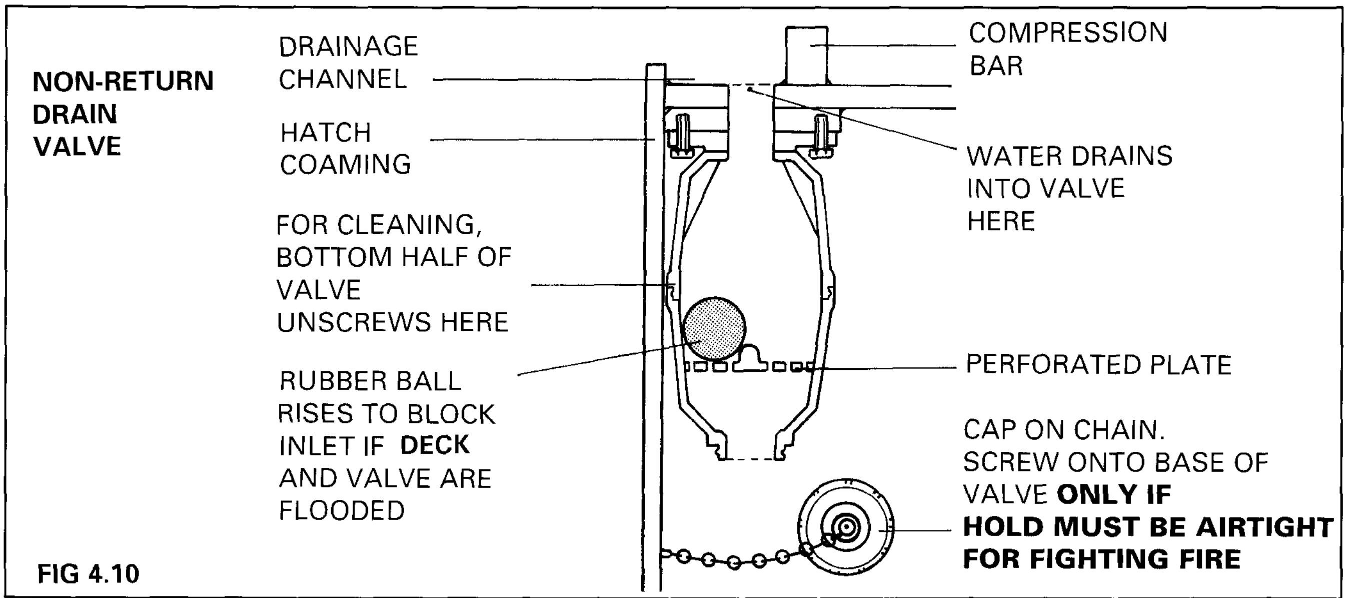


FIG 4.10

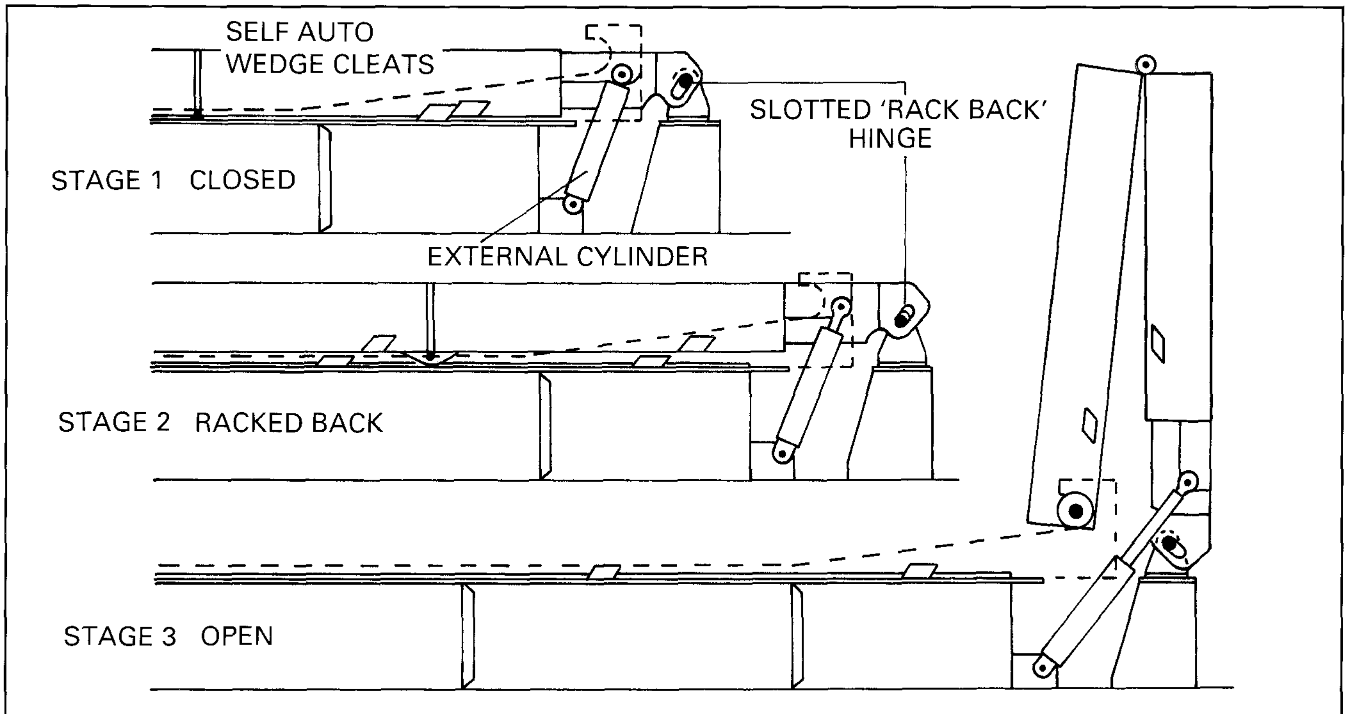


FIG 4.11

- Checking the residual thickness of coamings, steel pontoon or hatch cover plating and stiffening members as deemed necessary by the surveyor.

The *Record of Particulars Relating lo Conditions of Assignment* (of Load Lines) is a document which is isstiecl by the surveyor and normally kept with the Loadline Certificate. It provides a list of all the items that the surveyor will inspect when making his survey, and is a useful document for the master and officers to use as a checklist when ensuring that all is ready for the survey.

Testing or assessing the watertightness of the hatch covers

Hose test: A well established method of testing for hatch watertightness is by hose testing, a process which can only be carried otit when the hold is empty since it may result in leakage of water into the hold. The method requires the hatch to be closed and secured as for sea. A powerful jet of water taken by-hose from the fire main or deck service line is directed on to each part of every joint in the hatch cover in turn, and any point where leakage occurs is noted.

This process requires at least two responsible crew members, one of whom is likely to be the chief mate, equipped with walkie-talkie radios. The first person ensures that every part of every joint is hosed in turn and informs the second, in the hold, which seam is being tested. The second views the appropriate seam and makes a note of any leakage. Observing the location of the leakage can be difficult in a closed and poorly-lit hold with the hatch covers anything up to 18 or 20 metres above the observer. A powerful light is essential and binoculars may be useful. Thorough hose testing of one hatch of a handy-sized bulk carrier can be expected to take 20-30 minutes. Hose testing cannot be carried out in freezing conditions, for obvious reasons.

A manufacturer of steel hatch covers specifies that hose testing should be undertaken under the following conditions:

• Water pressure	4 bar.
• No/y.lc inside diameter	35-40 mm.
• Distance nozzle/object, maximum	1.5m.
• Rate of progress, maximum	1 m per 3 sec.

Chalk test: A second method of checking for hatch watertightness is by chalk test. The procedure is to rub chalk from chalk lumps or sticks along the full length of the compression bars and then to close and secure the hatches, when they are reopened the gaskets must be inspected for any places which have not been chalk marked by contact with the compression bar. Where there is no chalk mark on the gasket no contact with the compression bar can have been made, and the joint cannot be watertight. This method of testing shows where the compression bar has touched the gasket, but it does not show how firm the contact has been. Xor does it prove that, the compression bar remained in contact with the gasket in the final closed and secured state, and the value of this test is therefore limited though for the expert it offers evidence of the relative positions of compression bar and packing, which provides information about the hinge condition of folding hatches.

Ultrasonic test: Hatch watertightness can also be measured with convenient portable ultrasonic equipment powered by rechargeable batteries. The equipment consists of a transmitter which is placed in the hold, where it emits ultrasonic waves when switched on. An operator on the hatch covers then takes a hand-held detector along the length of each joint in the covers. In any position where the seal is not tight the receiver emits audible sound and an accurate reading in decibels (dB) can be taken from the luminous display.

The sound emitted by the detector is like a low whine emitted by a badly-tuned radio. The noise will go up when a leaking area is found, at which point, it is useful to hold the detector close to the joint to determine the exact limits of the leak. When these have been found the button can be pressed for a digital value, which gives a more accurate measure of the severity of the leak. At other times there is no need to hold the detector close to the joint.

At short ranges (for example, from 'tweendeck level) the signal strength will remain constant at a maximum value and the equipment can be used without calibration. When the range is greater, as when the transmitter is situated on the tanktop of a bulkcr hold, it will be necessary to calibrate the equipment before testing is carried out.

The instrument detects exactly the same leaks as would be found by an efficient hose test, it is claimed, but avoids many of the problems associated with the-latter. Advantages claimed for ultrasonic test equipment are that it:

- Can be used by one man.
- Will not damage cargoes.
- Can be used when temperature is below free/ing.
- Reveals the exact location of any leak.
- Isaccurate.
- Is simple to use and requires no special training.
- Is compact and portable.

The equipment, marketed by MacGregor-Navire, also has numerous other uses for the monitoring of mechanical wear and pneumatic and hydraulic leaks.

Visual inspection of the covers: A visual inspection of the hatch covers can show defects which make it impossible for the hatches to be watertight. In bright daylight rays of light can be very obvious when seen from within a closed hatch. Damaged compression bars and neoprene gaskets which are permanently compressed are signs that hatch watertightness has been lost. 'Locating pieces' which guide the panels into the correct position may become damaged, worn away or built up with scale. As a consequence panels will not seat as intended—they may remain out of contact with one another, or one may be forced up out of contact with the coaming.

All of the above methods of testing and inspection relate only to the watertight integrity of the hatch covers at the time of the test, and cannot prove that the hatches remain watertight when the vessel is working in a seaway or is exposed to changed hogging and sagging stresses. Nevertheless, the tests and inspections are valuable in drawing attention to defects in the hatch covers, making it possible for improvements to be made.

Visual inspection of the cargo: A final way in which the ship's officers can assess the watertightness of the

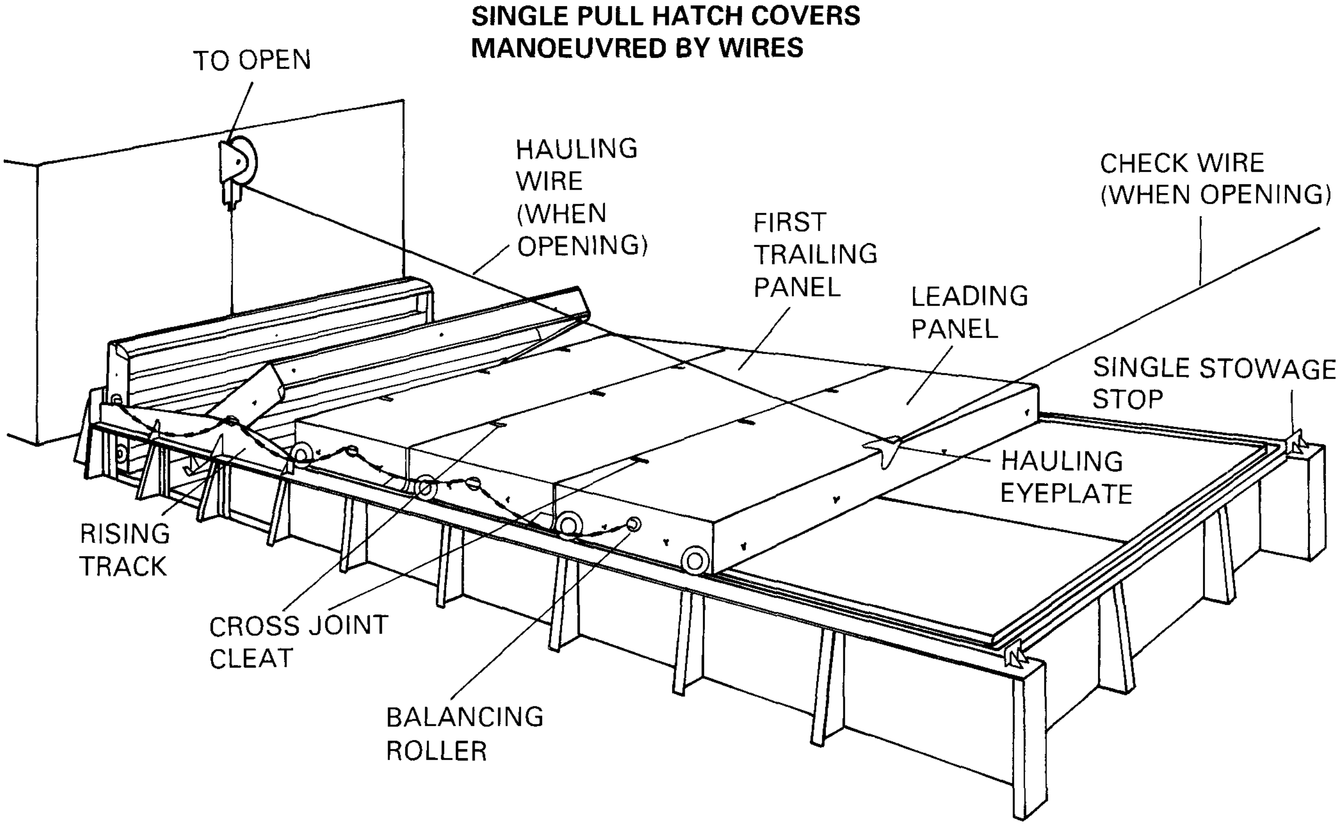


FIG 4.12

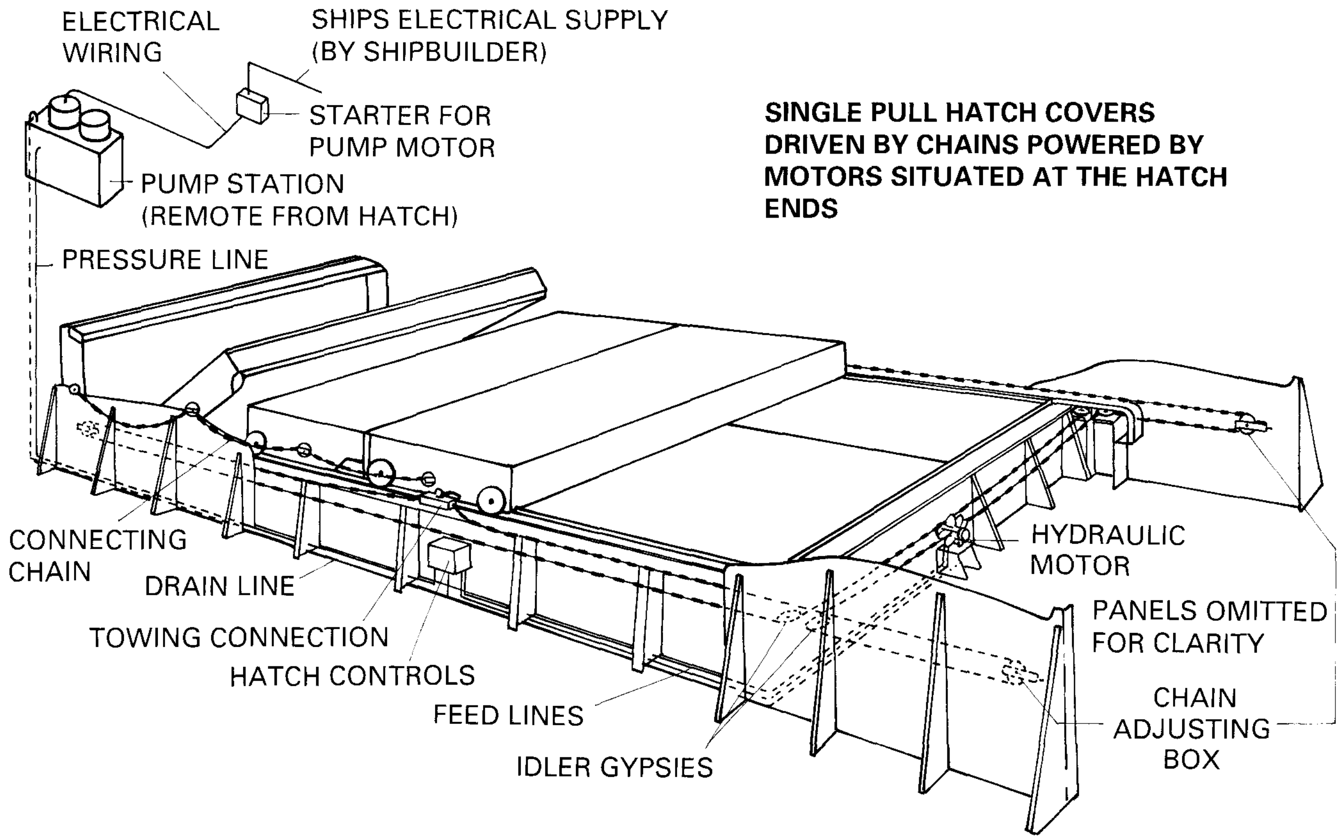


FIG 4.13

hatches is by careful inspection of the cargo in way of the hatch coaming immediately upon opening the hatches at the end of a sea voyage. No opportunity should be missed to make this inspection, since the information which it provides can be very useful. If spray or seas have been shipped, or even if there has been torrential rain, leakage will almost always show itself in markings in the surface of the cargo and sometimes in staining on the vertical sides of the hatch coaming. If the drip marks are very regular they are probably due to condensation, but if they are irregular and concentrated in certain positions they are almost certainly due to leakage.

Some cargoes are unaffected by sea water and in some ports the receivers are indifferent to signs that leakage into the holds has occurred. That is never an excuse for the ship's officers to ignore signs of leakage-they should always make a note of the positions of any signs of leakage which they see. At the earliest opportunity steps should be taken to carry out appropriate maintenance and renewals to eliminate the leaks.

Procedures for maintaining hatch covers in efficient condition

All steel hatch covers have four basic features—their strength, operating system, watertightness system and safety features.

Any loss of strength as a result of damage or corrosion is easy to see. A failure of the watertightness system is quickly noticed and becomes cause for concern when leakage occurs. Manufacturers state that operating systems, on the other hand, are often neglected and only cause concern when they have failed, usually in inconvenient circumstances. Safety features are frequently ignored.

Maintenance in general: There can be no doubt that inadequate maintenance is a major cause of many hatch cover defects. The marine environment is a harsh one. Damp salt-laden air, water on deck and dusty, abrasive cargoes all take their toll on a ship's structure and fittings, which deteriorate rapidly if proper preventive measures are not taken. Yet it is too often evident from the condition of ships presented for survey and repair that such measures have been neglected. This is inexcusable. Damage to cargo by the entry of sea water costs money, and in extreme cases leakage can lead to the loss of the ship.

The increasing size of ships, coupled with their reduced time in port and their smaller crews, serves to make maintenance programmes more difficult to complete. There are limits set by time and by operating conditions to the amount of work that can be completed by ships' staff, and some ship operators nowadays make use from time to time of the maintenance services offered by hatch cover manufacturers.

It is essential that hatch covers receive regular maintenance and the workload becomes much heavier as the ship reaches 'middle age'. Work must be progressed whenever conditions permit, and this requires the chief mate to have a good understanding of the requirements for hatch maintenance.

It is impossible in a book such as this to foresee and to describe the precise maintenance requirements for the hatch covers of any particular ship, but certain advice can be offered and common problems can be described. MacGregor-Navire state that the maintenance tools which they would like to see used most often are grease guns and brooms! If the hatch covers and coamings are swept free of cargo and other rubbish, and if the moving parts are properly greased, the hatch covers should give many years of good service.

Leakage in way of hatches can be caused by faulty hatch operation, damage to hatches, excessive wear of components and neglect of maintenance.

Manufacturer's literature: It cannot be emphasised too strongly that the master and chief mate should ensure that they possess full and legible copies of the manufacturer's literature for the hatch covers. The operation and maintenance manuals should be studied, and the procedures should be understood and followed. A chief mate who is not thoroughly familiar with the hatch covers on a vessel to which he has been appointed is well advised to give high priority to a study of the manuals, and also to study with care the operation of the hatch covers. In addition he should seek information from the ship's records and from his colleagues as to any problems met in the past. Hatch covers need regular attention and if they are neglected even for three or four months before the chief mate gives them his full attention the time which has been lost will be difficult to regain. The engineer officers can often provide good advice when it is needed, since maintenance of machinery is one of their specialist areas and deck machinery is, in principle, like any other machinery.

Safety measures: Whether hatches are open or closed they should always be secured in position. An unexpected roll as another ship passes, a gradual change of trim, a hydraulic failure—any of these things can cause hatch panels to move and to become dislodged if they have not been secured. Securing devices such as hatch retaining latches (Fig. 1. 26) are always provided. They should be maintained in good condition, and used.

Before commencement of cargo work: Cargo escaping from loading conveyors or discharging grabs is likely to drop on a bulk carrier's hatch coamings and may fall into the drain pipes set in the coaming. This can be prevented by fitting temporary plugs in the mouths of the drain pipes. To make sure that they are not forgotten, such plugs should be long ones that stick several centimetres above the coaming.

The need to sweep the hatch coaming channels will be reduced if the hatch coamings are covered with heavy duty canvas or plastic sheeting before commencement of cargo work, and this procedure is especially recommended in freezing conditions, when coamings are particularly difficult to clean.

Securing for sea-need to clean: Before closing hatches for a sea voyage it is necesssary to ensure that all compression bars and gaskets have been thoroughly cleaned, to ensure uninterrupted contact between compression bar and gasket. Since cargo is almost always spilt during loading, the cargo residues and any other foreign matter will have to be carefully removed. This is done by shovelling and sweeping, then by 'washing' with a compressed air hose. Compressed air is most useful, both for speed and thoroughness, and should be applied with a compressed air gun which

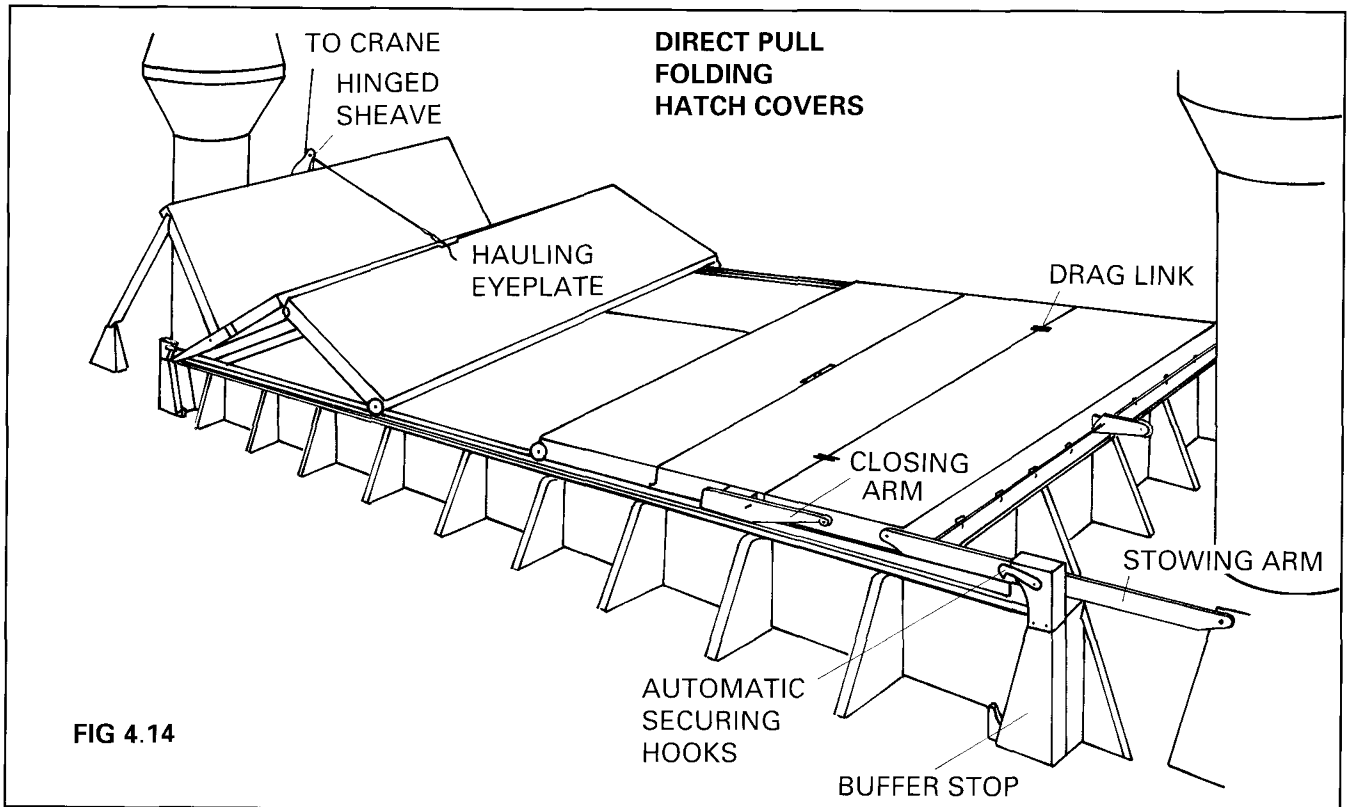


FIG 4.14

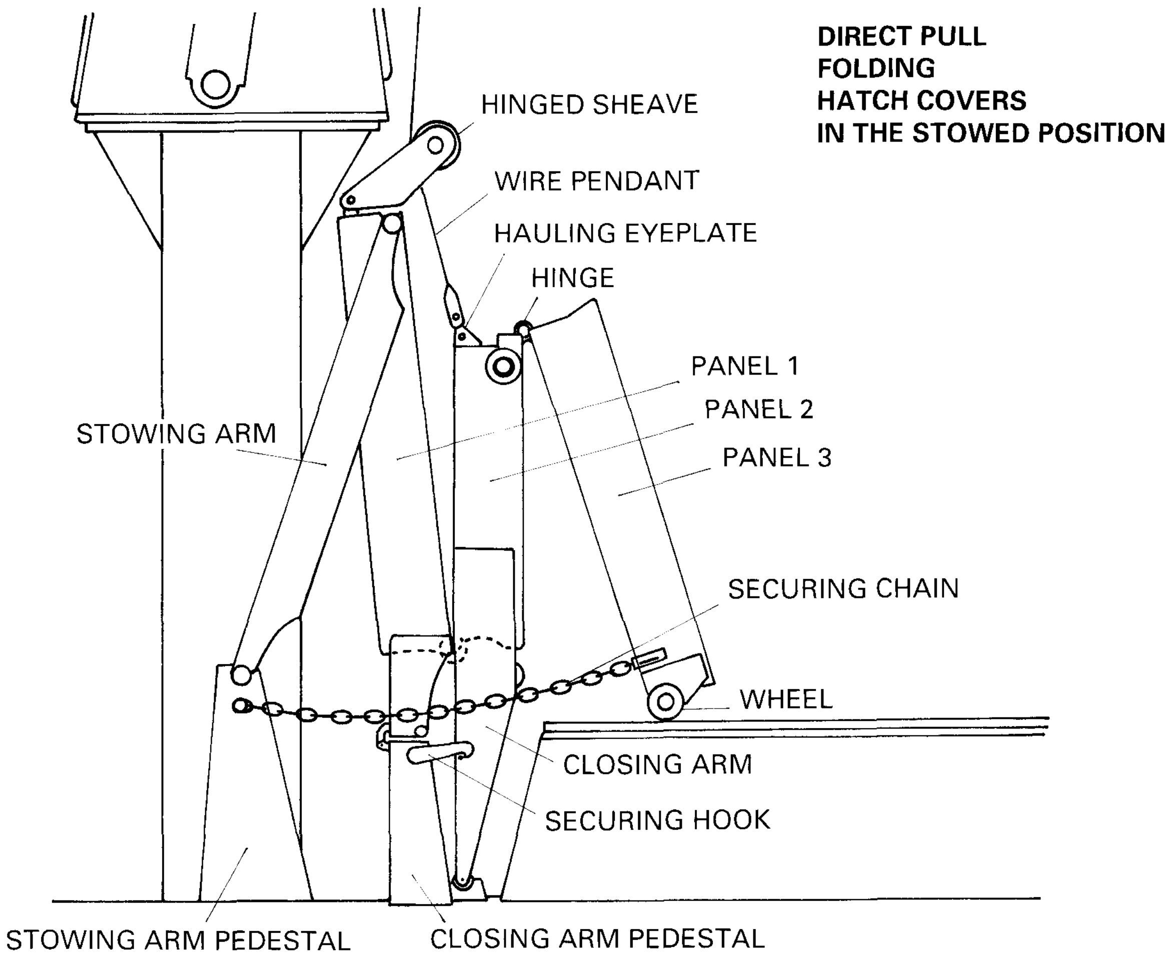


FIG 4.15

enables the air to be directed on to the area to be swept. This avoids wasting air and annoying the chief engineer! A compressed air gun on the end of a length of solid pipe is a useful tool for directing compressed air at the coaming from a safe distance. Care should be taken to avoid compressed air coining into direct contact with exposed skin, since this can cause cancer, can blind and can catise dermatitis if cargo dust is blown under the top skin layers.

Quantities of cargo are sometimes spilt on hatch covers. This should be removed before the covers are moved, as they may be damaged by the extra weight. It is equally important to make sure thai all drainage channels and drains are clear, to allow drainage of any water which penetrates the seal. Drain pipes are best cleaned with compressed air applied from below and directed tip towards the coaming. If the drain pipes have been plugged, it is essential that they are unplugged before the vessel puts to sea. Long plugs are easily seen and cannot go unnoticed when the hatch is closed.

This cleaning work must be done with equal care every time that the hatches are secured for sea, regardless of the time of day or night, or of the weather conditions. It is i'alse economy to rush the closing of the final hatches on completion of loading; it is more important to ensure that they are properly and carefully secured for the sea voyage. Delay should be kept to a minimum, however, by ensuring that all other holds have been closed and secured before completion of loading in the final holds.

Securing for sea—correct sequence and hatch panel position: Even when several alternative sequences for closing the hatch are possible, the sequence recommended by the manufacturers should be followed, and every precaution must be taken to ensure that the hatch panels are correctly positioned when the\' are lowered onto the coaming. If a panel is wrongly positioned the cleats will not meet truly. They should not be forced; the panel must be correctly repositioned.

With single-pull covers it is imperative when closing the covers prior to battening down that the leading panel is properly located. Next, the hauling wire must be shifted from the leading panel to the trailing panel and again pulled tight to ensure that all of the sections are properly mated in relation to each other, so that the transverse compression bars are in the centre of the gaskets. Experience shows that leakage is likely to occur in way of the cross-joints as a result of the ship working if the compression bars are not placed centrally on the gaskets, or rubber seals. In Fig. 4. 1 the panels are correctly located and the compression bar is centrally placed below the rubber seal.

If cleats have to be fastened manually, the manufacturer's recommended sequence must be followed, since uneven tightening of cleats can alter the flexing and watertightness of the covers. Such a sequence might call for the cleats on transverse joints to be fastened from the centreline outward in both directions simultaneously. For longitudinal joints in the case of single-pull covers the sequence might be from the leading panel to the trailing panel, simultaneously on both sides. In the case of folding covers the recommended sequence could be from the fore and after extremities to the centre joints. Such sequences are intended to minimise the likelihood of distortion of the panels and damage to the fittings and should be strict!}' observed.

It is also necessary to guard against carelessness and negligence in closing hatches. The work will be shared between a number of crew members, possibly over a period of hours, and in these circumstances it is possible for some steps to be overlooked. It is normal for the chief mate and/or duty mate to satisfy himself that all hatches are properly secured before the ship puts to sea, and this procedure should be followed with commitment. Good practice is for the chief mate to check that all coamings, cross-joints, gaskets and drains are clean before the hatch is closed, and for the duty officer to ensure that the correct closing sequence and dealing procedure has been carried out.

Prevention of damage to hatches by stevedores: Damage to the hatch covers, hatch coamings and associated fastenings is most likely to be caused by the discharging and loading processes. Fittings may be struck by grabs, by items of mechanical loading or discharging equipment, or by heavy items of cargo such as lumps of quartz or pig iron. The compression bars and those hatch rubbers and channels which are open to the hold are items which are often damaged. Ships' officers must be alert to the possibility of damage and must ensure that the person causing the damage is quickly served with a written notice, holding him responsible. This may ensure that the damage is repaired and may make the person who caused the damage more careful to avoid further damage.

Prevention of damage to hatches by crew negligence: A further possible catise of damage to hatch covers and their fittings is an accident when closing or opening the covers, perhaps resulting in broken or distorted fittings. Accidents of this sort are sometimes caused by a failure of crew members to make all the necessary checks to ensure, for example, that all cleats are disengaged, that all trackways are clear and that all chains, wires or cables are free to run before the panels are moved. Such accidents are most likely to occur when crew members are inexperienced, tired or working in difficult conditions. At such times their work should be more carefully supervised.

Prevention of damage to hatches by operation at sea: Another cause of damage can be the opening or closing of hatches at sea when the ship is moving in a seaway. When the ship is in ballast with a large freeboard and the seas are calm, it is convenient to open the hatches for maintenance purposes and often it is necessary to do so to achieve efficient hold cleaning. In principle this is no different to opening hatches during a sheltered river passage or in the approaches to the loading or discharging berth, btit problems can arise if the seas get tip a little during the course of the da}1 and the ship is pitching or rolling perceptibly when the time comes to close the hatches, or if the hatch panels have not been secured whilst open. It is a sobering thought that some 20 hatch panels are lost overboard each year from large bulk carriers because the}1 were not properly locked down.

The nature of the problem varies with the type of hatch covers fitted. Single-pull systems are vulnerable

POWERED FOLDING HATCH COVERS

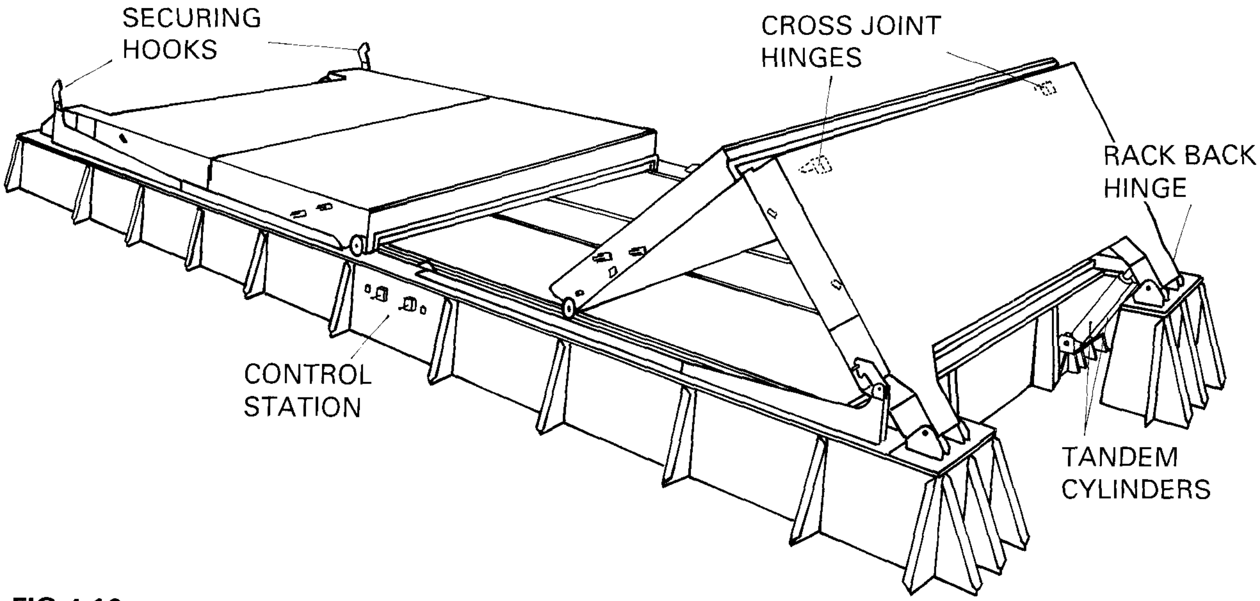


FIG 4.16

ROLLING HATCH COVERS

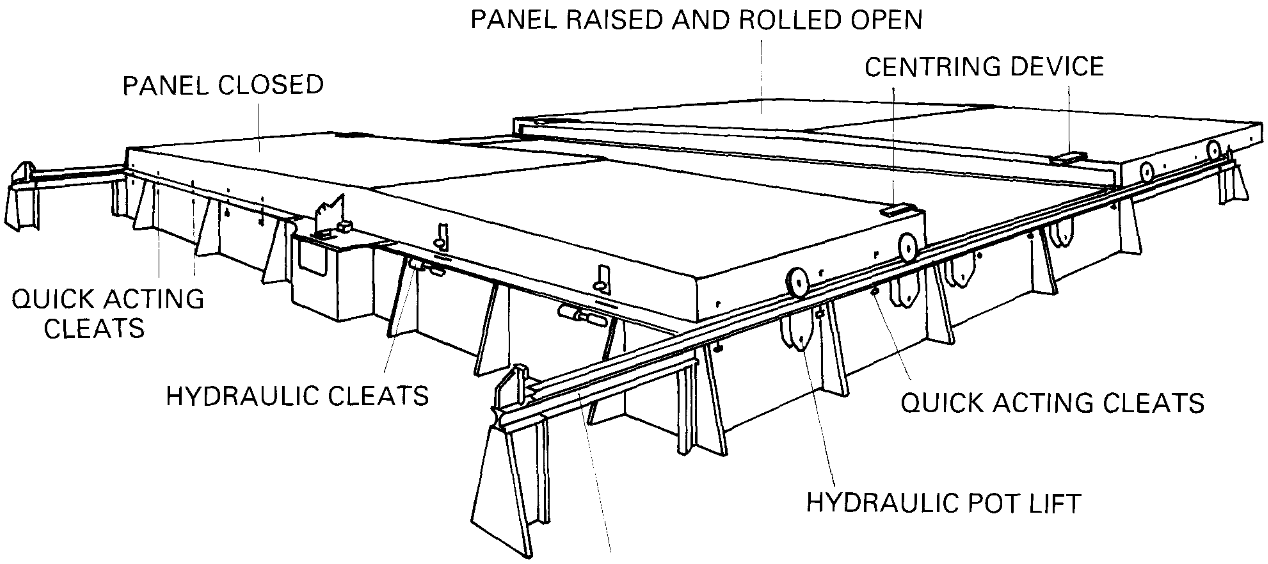


FIG 4.17

at the point where the panels tip into the stowage position, and any wire-operated single-pull or rolling system is dangerous if the ship's movement causes the panel to roll towards the hauling wire. A check wire leading in the opposite direction must he rigged and kept taut (Fig. 4. 12). When hatch covers are open or partly open, all panels must he well secured. Wherever possible they should be lowered from their wheels or steadied with check wires, as appropriate, with all fastenings being symmetrical to ensure that panels cannot slew.

If a ship does start to move in a seaway with hatches open, the movements of the panels can become violent and uneven and hatch fittings can be damaged. This is a situation which needs continuous and careful watching. Hatches should not be opened when there is a danger of pitching or rolling which will disturb the hatch panels. If the ship starts to move noticeably when hatches are open, they should be closed with no delay, except to bring the ship on to a course with the seas astern if necessary to make her more stead}'.

If a hatch is damaged, the damage must be carefully assessed to decide whether the hatch can still be opened and closed and whether it remains watertight. The nature and timing of repairs will depend upon the circtimstances. Some masters and owners make it a rule never to open hatches at sea and, when the ship's design and her service allow it, the rule can be strongly recommended.

Treatment of wear and corrosion: Even when hatch covers and their associated fittings are all properly used and set up, the gradual processes of wear and corrosion will introdtice changes. The exposure to salt water and to dust which is a feature of bulk carrier operations will accelerate these processes. Gaskets will become permanently compressed. The amount of play in the hinges of folding covers will increase. Compression bars will become wasted, and corrosion will cause the retaining bars of the gaskets to swell and become distorted. It is necessary for the chief mate to inspect the hatch covers regularly for these gradual changes. Warning that the condition of the hatch covers is deteriorating may be given by small changes in the way that the hatch covers open or close. Xone of the foregoing can be neglected and worn items and slack fittings must be renewed, repaired or adjusted.

Lubrication: The condition of hatch covers will deteriorate very rapidly if they are deprived of routine lubrication. Parts which are not greased will quickly seize up. Seized parts which are hammered or heated to free them will be damaged and will eventually require expensive repair. A regular greasing routine must be followed, to ensure that moving parts are greased once a voyage or once a month, or at whatever interval is appropriate to the trade in which the ship is employed. Bearings (joints where two metal parts arc fitted together and one rotates within the other) in hatch fittings, as elsewhere, require to be lubricated and are normally fitted with grease nipples to permit the injection of grease between the moving parts. Sometimes grease nipples are missing or broken and it is important to lit new nipples so that grease can be applied. The person applying the grease should look for signs that grease is being forced out of the far side of the fitting which is being greased, as evidence that the process is working efficiently.

Care must be taken to use only the manufacturers' recommended quality of grease. Unsuitable greases may provide inadequate lubrication, with different tolerances, operating temperatures and pressures, and may also lead to the creation at the boundary between two non-compatible greases of a solid 'plug' which can completely block the grease channel.

Painting of batch covers: The painting of those parts of hatch covers and coamings which are visible when the hatches are closed presents no special problems. Painting with airless paint spray is recommended, particularly for the hatch coaming sides, in view of the irregularity of the surface, though it maybe better to use paint rollers when the crew are unskilled and the weather is rough. Before painting commences, all hydraulic pistons in jacks and automatic cleating devices must be suitably protectcd-for example, with plastic film held in place with masking tape. The back of all pipework secured to the hatch coaming must be painted as well as the front. The purpose of the painting is to protect the pipework from corrosion as well as to improve its appearance.

The scaling, wire brushing and painting of the undersides and the ends of the hatch panels presents greater problems. Normally this work can only be done whilst in port or at anchor and with the holds empty. The method adopted will depend upon the design of the hatch covers. It may be necessary to stand on one hatch cover whilst maintaining the next one in a stowed or partly stowed position. This work is potentially dangerous because it is done over the full height of the empty hold, and because the hatch panels may not be securely stowed and will have to be moved as the work progresses. Crew members must be protected from falling into the hold and from being injured by moving panels. The maintenance of the cross-joints with their drain channels, gasket retaining bars and compression bars is vital to the preservation of hatch watertightness, but favourable opportunities for this work will be rare. When an opportunity does arise this work must be given high priority.

At the time when hatch panels and coamings are painted, care must be taken to ensure that all drainholes are clear and than none is blocked and painted over.

Spare parts to carry: Spare parts for hatch covers are not available off the shelf in every part of the world; a minimum stock of spares should be carried for emergency renewals by ships trading worldwide. Such a stock should include sufficient gasket rubber for at least two hatch panels, including the specially moulded corner pieces, with the necessary adhesive. In addition, at least one specimen of every fitting in the entire hatch manual should be carried to fit following accidental damage, and a replacement should be ordered immediately the stock item is used. The foregoing is a minimum for emergency repair and takes no account of the needs of maintenance.

For maintenance purposes, a good supply of spares must be carried-the number required increasing as the ship grows older. For items such as the neoprene washers in quick-acting cleats (with a life of perhaps two years) it will be necessary to carry 25 per cent of

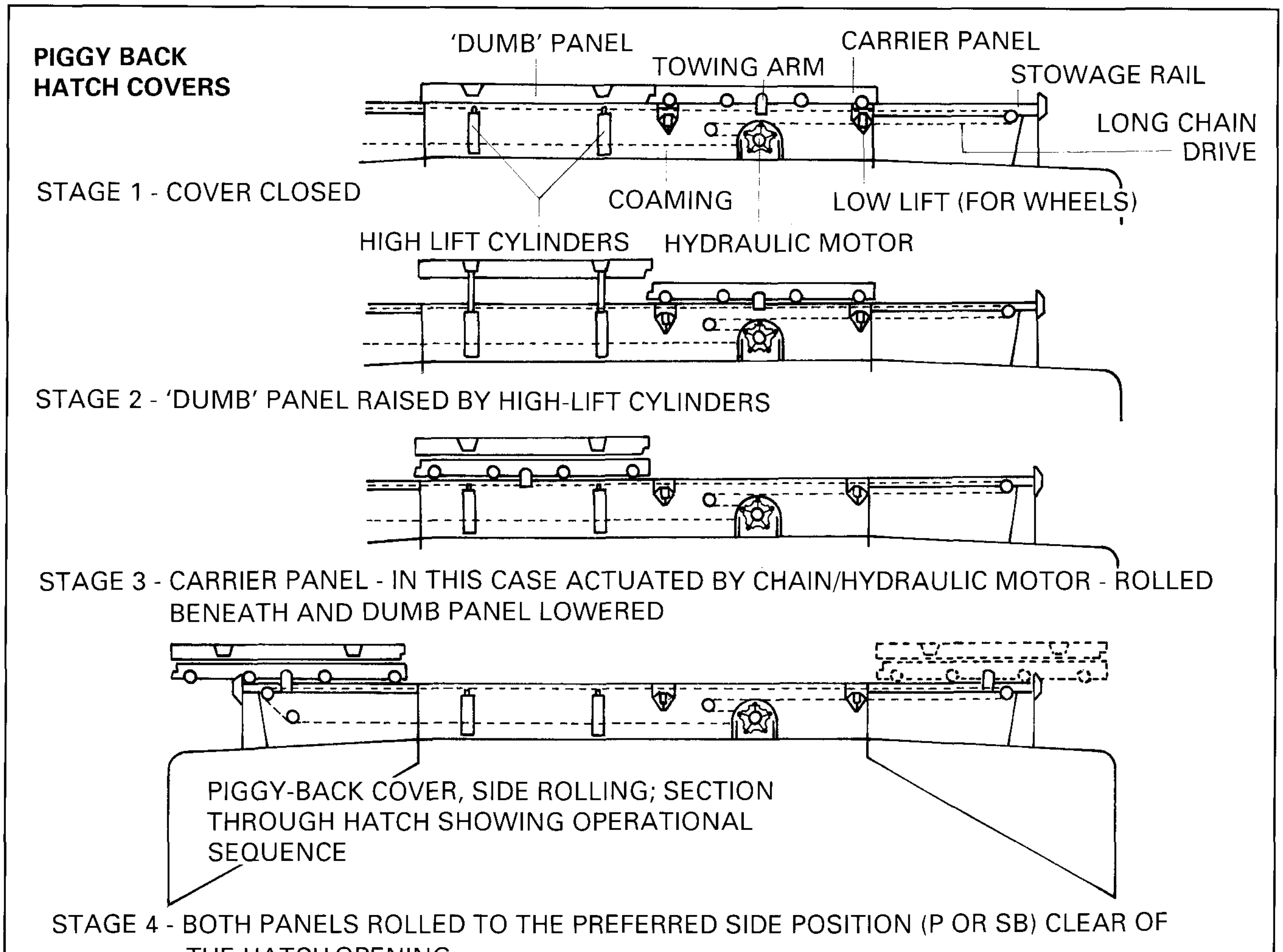


FIG 4.18

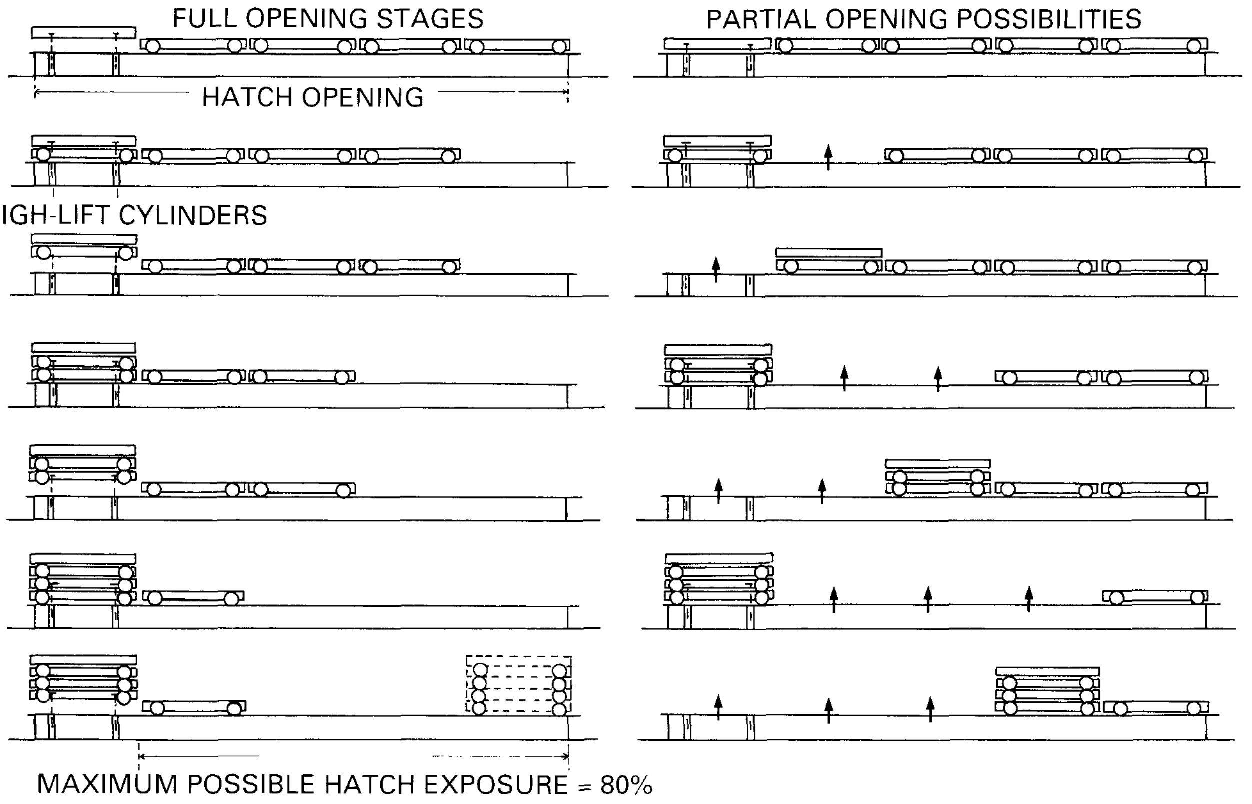


FIG 4.19 STACKING HATCH COVERS

the full fitted stock. A good stock of all items exposed to heavy wear, such as quick-acting cleat units, seals for hydraulic units, and roller bearings for panel wheels, should be carried since such items can be difficult or expensive to obtain at short notice. An adequate stock would be 25 per cent of those fitted, or sufficient for one complete hatch, whichever is less.

A stock of spare hydraulic jacks and hydraulic dealing devices should be carried on ships that have these fittings so that replacements can be fitted whilst the discarded units are reconditioned. By the time the ship is ten years old it is likely that spares carried, new and reconditioned, will amount to some 10-20 per cent of the total installed.

It is not recommended that a large stock of neoprene gasket material be carried, except when renewals in the near future are intended. The fitting of replacement gaskets is skilled work and is best undertaken by experienced staff. A number of spare jointing shackles for hatch panel chains should be carried, along with sufficient hatch opening and closing wires for 100 per cent, replacement, on ships with the wire-operated single-pull system.

Some *defects found in hatch covers*

Permanent setting down of gaskets: Many people believe that the tighter a cover is secured to its coaming, the better the seal that is made and the smaller the chance of leakage. This view is a mistaken one, since the hatch is designed to be closed with steel-to-steel contact. When this very important principle is not understood much money and effort can be wasted.

Figs. 4.1 and 4.8 illustrate the manner in which steel-to-steel contact is supposed to occur. When the hatch covers are newly installed the original dimensions of steel and gaskets (i.e., rubbers) are such that gasket compression of more than 25-30 per cent is impossible. Provided that solid steel-to-steel contact has been achieved between hatch cover and coaming, nothing can be achieved by overtightening the cleats. Overcompression of the gasket can only occur if the contact faces of the steel have been worn down or corroded, as often occurs in older ships. In these circumstances it is pointless to renew the gasket before the full depth of the steel has been rebuilt.

Once gaskets have been permanently set down by overcompression, their characteristics are irretrievably changed and their sealing properties are lost. The length of life of a gasket depends upon the trade and the treatment to which it is exposed. Gaskets are designed to withstand a set number of operations rather than a life span in time, and hardening, cracking and failure; of the gasket will result from a build-up of scale in the channel into which the gasket is set, particular!)' if the gasket has been over-painted, coated with grease and not. kept clean.

When gaskets are renewed, it is recommended that replacement gaskets are purchased from approved suppliers since alternatives, although cheaper, are unlikely to be constructed to exactly the same specifications. If their cross-section or properties are different they will not give as good a performance.

It is unwise to insert short lengths of new gasket into a panel which is otherwise fitted with an old gasket. This is almost certain to result in a poor fit, with leakage. Building up old gasket with lining strips is also not recommended and is rarely successful. It does not give back to the damaged gasket the qualities it previously possessed.

Damaged or corroded compression bars: Damaged and corroded compression bars are frequently met, although better built ships are nowadays provided with stainless steel compression bars to reduce corrosion. If the compression bar (Fig. 4.22) is damaged and uneven it will permit leakage. Damage should be repaired at the first opportunity, probably with runs of welding, buffed to achieve a smooth and even finish.

Damaged or corroded gasket retaining bars: Gasket retaining bars (Fig. 4.1 and 4.8) when fitted are about 8 mm thick. They may easily suffer damage or wastage. If they do, the gasket will not retain its intended cross-section and the likelihood of leakage will be increased. Retaining bars should be kept free of rust and protected with paint. When they are damaged they should be repaired. If they become wasted they should be renewed.

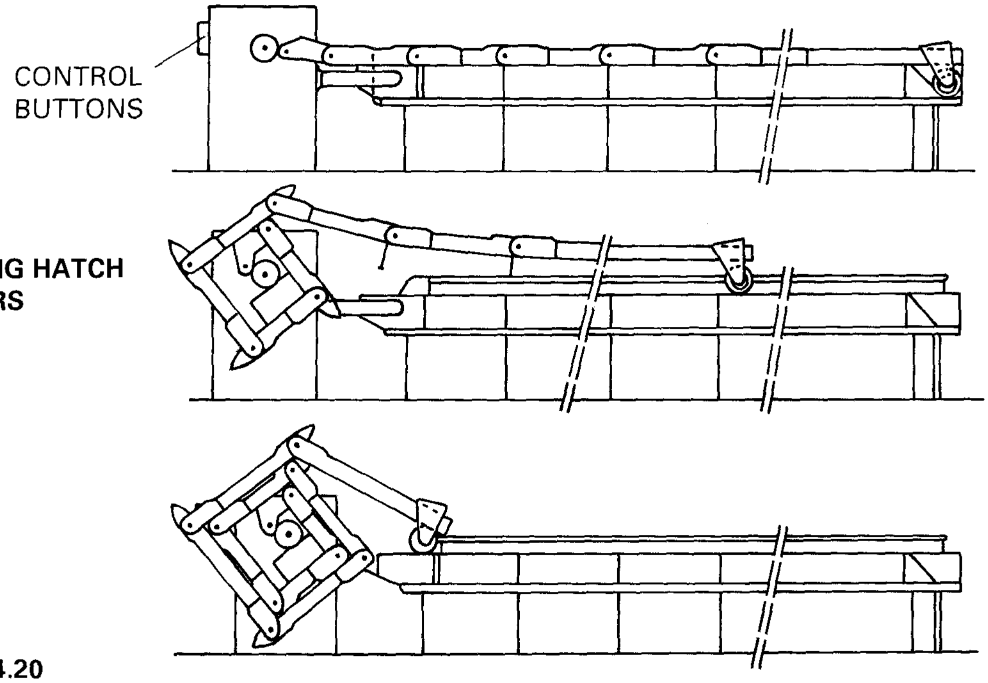
Blocked drainage channels and drain pipes: If a hatch seal fails it is possible that, the adjacent drainage channel will allow the water to drain away without doing any damage, but only if the channel and drain pipe are clear. Drainage channels on the hatch coamings and between adjacent panels must be cleaned as a matter of routine before the hatch is closed and secured and should be kept scaled and painted.

The hatch coaming drains are fitted with non-return valves (Fig. 4.10) consisting of a float in a chamber. If water shipped on deck starts to rise in the drain the float rises and blocks the inlet, preventing water from entering the hold. The bottom part of the non-return valve chamber can be unscrewed from the drain to permit cleaning of the valve as necessary. Instead of being fastened direct to the coaming the valve may be in a drainpipe, which must also be kept clean. If not dealt with as a matter of routine this cleaning can easily be overlooked. It therefore requires special attention from the ship's officers.

A screwed cap on a lanyard is provided at the base of each drain pipe. This is for achieving airtight sealing of the hold in the event of fire, and should never otherwise be fitted. Inexperienced people often fail to understand this and mistakenly fit the caps, which makes the drainpipes completely useless. This mistake must be guarded against.

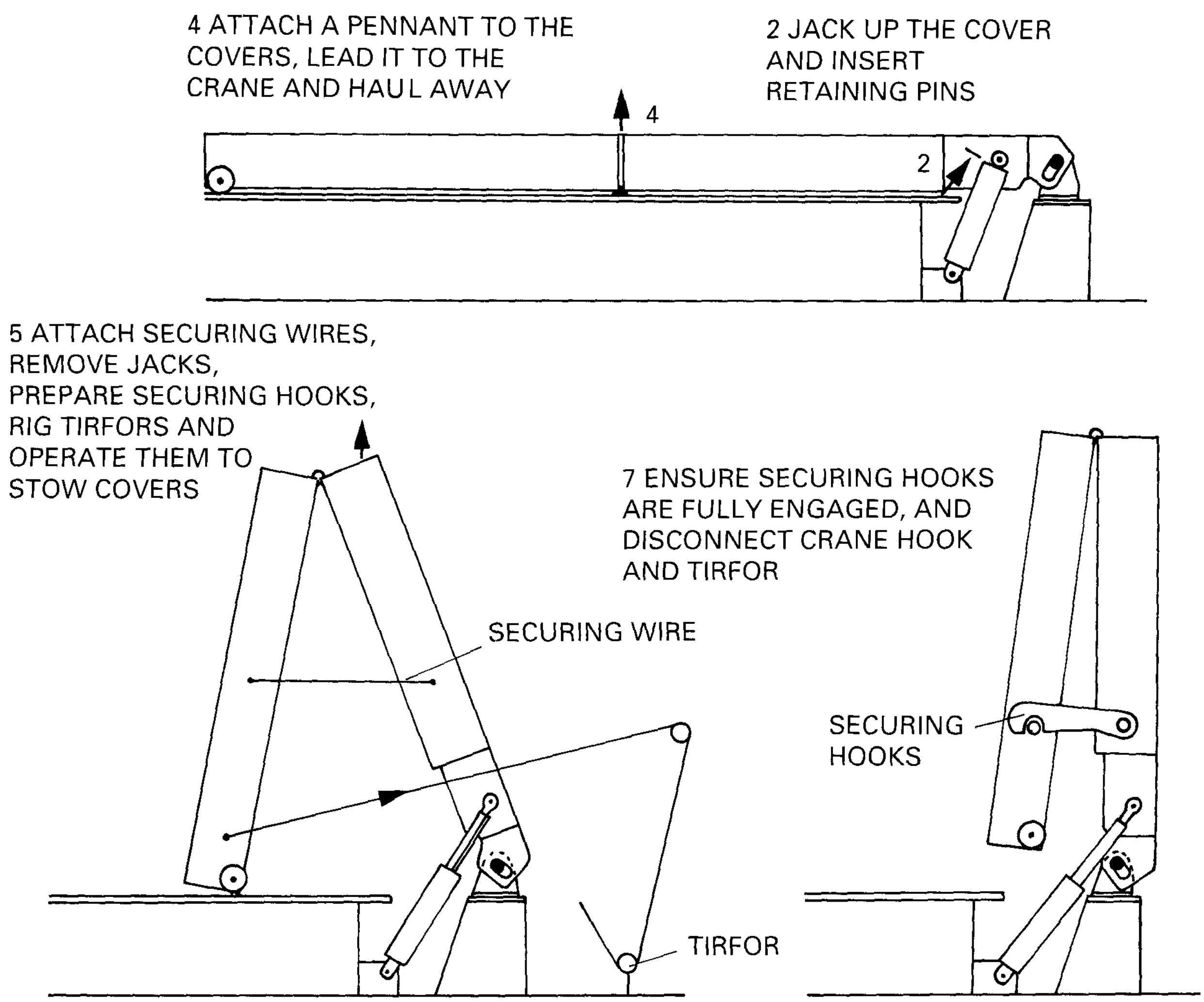
Clearing devices: dealing systems are designed to withstand dynamic forces on the hatch cover which may be subject to loading from above or, in the case of ballast holds and the hatches of OBOs and ore/oil carriers, to hydrostatic loading from below. (The-special features of the hatch covers of combination carriers are described in Chapter 18.)

Different hatch cover systems use different dealing methods, with dealing located at. key load transmission points throughout the coaming. These cleats are exposed to heavy use and hard wear. They must be regularly inspected, kept in good working order, properly adjusted and capable of further adjustment as required. It is good practice to keep a number of fully assembled spare cleats to fit in place of cleats which are found to be damaged or defective. When the



COILING HATCH COVERS

FIG 4.20



EMERGENCY OPENING OF RACK BACK FOLDING HATCH COVERS

FIG 4.21 FOR FULL INSTRUCTIONS SEE ACCOMPANYING TEXT neoprene washers in quick-acting cleats (Fig. 4.2 and 4.3) have lost their elasticity and become permanently deformed they must be renewed.

Connecting chains: On single-pull covers the connecting chains between individual hatch panels are subject to stretching in service and must be inspected for signs of this. With experience it is easy to see when stretching has taken place, as the chains then hang down to the level of the coaming rest bar, or below, whereas they should hang in a very shallow curve which does not reach as low as the coaming rest bar (Fig. 4.23). Tt is also important to keep a check on the amount of stretching which has taken place, since stretching weakens the chains. When they have stretched 15 per cent they should be renewed.

An efficient way to monitor the amount that each chain has stretched is to measure and mark a standard length (2 metres, for example) on each chain when it is new and to remcasure from time to time. When the distance between the marks, which could be wire seizings, has increased to 2.3 metres the chain must be renewed. When chains have been weakened by stretching it will be found that they stretch more rapidly and require more frequent adjustment, so there is no purpose in keeping them in service.

If both connecting chains have stretched, adjoining panels will fail, or will almost fail, to engage with one another as they drop to the horizontal when the hatch is being closed. If one chain has stretched, the panels tend to turn or 'crab' as they are pulled over the hatch. Manufacturers' adjustment routines for connecting chains should be followed, with all chains adjusted in pairs-port and starboard-and the chain lengths maintained to the original criteria. The lengths of connecting chains can usually be adjusted with bottle-screws, whilst bigger adjustments to chains can be made by cropping a link where necessary, using burning gear or an angle grinder, provided that the end link is not of special dimensions and that the shackle can be fitted to the new end link. Putting a twist in the chain is a device which has been used to reduce its effective length, but this is not recommended under any circumstances since it also reduces its strength and increases wear.

Hydraulic systems—moving parts: Manufacturers report that the operating systems for steel hatch covers are often badly maintained, and that poor maintenance combined with components of inferior quality and poor repair techniques cause a large number of accidents. Warning signs are leaking glands, noisy systems, slow operating cycles and dirt}' filters.

Hydraulic jacks are used in many hatch closing systems to raise and lower the hatch panels. Hydraulics are also used in some systems for the automatic cleating of the hatches. Dust and fine particles, mainly from cargo sources, are among the principal enemies of hydraulic systems. They lodge in the seals of jacks and pistons and these items eventually fail unless they are regularly overhauled, cleaned and renewed.

The cleanliness of the system is vital. Hydraulic svstems are nowadays all fitted with filters in the return lines. These should be regularly cleaned or renewed and a sample of hydraulic oil should be submitted to the supplier of the oil, or to the service organisation of the hatch cover manufacturers, for analysis at least once every six months. It should be borne in mind that modern hydraulic systems are made to operate at up to 400 bar pressure. They deserve extreme caution, and safe procedures should be followed when personnel are close to hydraulic pipework.

Hydraulic systems—pipework: The failure of steel hydraulic piping as a result of corrosion, inadequate bracketing and vibration seems to rise to a high level in ships which are more than seven years old. Such failure is always cause for concern since it leads to the loss of quantities of hydraulic oil, possible pollution claims, decks which are dangerous and slippery, and delays to the ship as a result of the inability to open and close hatches as required. Pipework failure can be redticed by ensuring that the pipes are kept properly painted, at the back as well as in the visible areas, but a better method (though initially more expensive) is to wrap all pipework, particularly unions between mild steel and flexible hose, with a protective tape such as Densotape. Additionally, when pipes are renewed the new lengths must be secured with brackets, and brackets must be cushioned with gaskets to prevent wear resulting from vibration and flexing. Experience shows that when pipes start to fail in numbers it is worth carr\ing an extra engineer or mechanic for a few weeks to carry out wholesale renewals.

Hydraulic failures at the union between mild steel pipe and flexible hose are common. They can be reduced by protecting the union with Densotape, as mentioned previously, and by rotitinc renewal of the flexible hoses at regular intervals, perhaps of five years. It is essential to have spare unions made up ready to fit. If necessary a new fitting can be welded on to the steel pipe and, if the ship's engineers are prepared, professional and experienced, the job can be completed within SO minutes.

Hydraulic systems-loss of pressure: If a hydraulic system is not operating at the intended design pressure, the consequence may be a cleating system which does not fully engage or disengage the cleats, or a hatch cover manoeuvring system which fails to place the hatch panels in the fully open or fully closed positions. If the loss of pressure is due to a leak this will be obvious, as will the remedy. More likely causes of low pressure are pump wear and incorrect pressure adjustment of the system, whilst in older ships which have filters in the suction line these filters can easily become blocked, causing reduced line pressures.

If the ship is pro\ided with a modern hydraulic system with a balanced pressure flow, and if the oil has been proved in good condition and the filters are clean but still a problem persists-call the manufacturer.

Hatch motors in exposed positions: Where hatch motors are installed in exposed positions—for example, when set into chambers within the hatch panels-it is essential that the seals to the chamber are maintained absolutely watertight and that the motor is inspected regularly to ensure that the chamber remains dry. If water is allowed to accumulate unnoticed in the chamber, the eventual result will be a motor which is burnt out and hatch panels which cannot be opened or closed.

Where motors are situated on the exposed deck they can be submerged when heavy seas are shipped. Check regularly, by inspection of the sight glass, that the luboil has not become contaminated with seawater. Regularly drain off any seawater which has been forced in through the bearings and check the oil for condition. Change the oil if it becomes milky or otherwise breaks down.

Hydraulic continuous chain drive to single-pull hatch covers: When replacement continuous chains are fitted to single-pull hatch covers, it is necessary to ensure that the chains are a matched pair. In addition to being the same length, they must also both contain the same number of links. If they do not satisfy both these requirements they will when operated cause the hatch panels to slew, with the risk that the panels will leave the trackway and fall into the hold.

Emergency opening and closing of hatches

Where the ship's cargo-handling and mooring equipment permits, it is normal for the manufacturers to make provision for the mechanical opening and closing of hatches in the event of failure of the automatic system. The emergency procedures for a ship like the *Regina Oldendorff* can be quoted as an example of the procedures which have to be followed.

The vessel is provided with 'rack back' folding hatch covers, with one pair of panels folding to the fore end of each hold and the second pair folding to the after end of the hold (Fig. 1.34). The covers are operated by hydraulic cylinders powered by two electric/hydraulic pumps, and the cleating is by mechanical wedge cleats which operate automatically in response to the weight of the hatch panel.

When one hydraulic pump is out of order, the covers can be opened by a single pump, but the speed of the operation will be halved. If both hydraulic pumps are out of order or the hydraulic system is damaged the hatches must be opened by mechanical means. The procedure is as follows. (Fig. 4.21)

1. At every stage the hydraulic controls must be set in the correct position as if the covers were being moved by the hydraulic system.
2. Jack up the hatch cover with two manual jacks placed in positions provided. This disengages the cleats and relocates the hinge pins in the slotted rack back hinges at the hatch end.
3. Insert emergency retaining pins to hold the hinge pins in the correct positions in the slots of the rack back hinges.
4. Attach a wire pennant to the lug on the covers close to the cross-joint, lead it to the crane or derrick, and haul away to raise the covers.
5. Attach the securing wires port and starboard, remove the jacks, and prepare the hatch cover securing hooks in the operating position.
6. Rig tirfor machines (lever-operated devices for hauling on wires) port and starboard, and operate simultaneously until covers are fully stowed.
7. Ensure securing hooks are fully engaged, and disconnect crane hook and tirfors.
8. When hatch covers are opened by wires they must be closed by wires, since the cylinders will be drained of fluid and the panels would otherwise fall uncontrolled.

Whilst the emergency procedure to be followed will vary from one design of hatch cover to another, there are some basic features which deserve attention.

1. The emergency opening and closing of hatches calls for the use of equipment-jacks, emergency retaining pins, securing wires, tirfors-some of which is never otherwise used. This equipment should be clearly labelled and regularly checked, or it will be lost when needed in an emergency.
2. The reminders about keeping the control levers in the correct position at every stage, and about returning the covers to the initial position by wire when they were first moved by wire, are most important.
3. The procedures ensure that the panels are supported and/or secured at every stage, and this is essential to guarantee safety and avoid damage when the operating system is not working.

Hatch leakage-first aid measures

High adhesive plastic sealing tape: High adhesive plastic (Ram-nek) sealing tape is sold in strips 1.2 metres in length by 7 cm, 11 cm or 15 cm wide. It is designed to seal the joints of closed hatches, so as to prevent the leakage of water into them when it is known or feared that the hatch seals are not watertight. The fitting of high adhesive sealing tape, if done over the entire ship, is very expensive in cost of material and in crew time.

The process is by no means guaranteed to be successful. As its best the tape forms a bond so strong that it takes the paint with it when it is eventually removed. Even when adhesion is good, however, it is difficult to fit a continuous watertight strip over joints which were not designed to be taped and which are often irregular, though Ram-nek provide a second product, Roaming-Aide, designed to meet this requirement. One disadvantage claimed for high adhesive tapes by their critics is that they set up a condition in which electrolytic action can occur, since they create a sealed zone environment containing salt air, water, steel and possibly additional metals. This can cause severe corrosion and weakening of the joint areas.

Good bonding requires a surface which is free from salt and grease, conditions which cannot be guaranteed. If the hatch covers are salty they should be washed with fresh water before being taped. Good bonding also requires warmth in the tape (which can be achieved by storing it in the engineroom in cold weather), and in the surface to which it is applied. These are not easy to achieve and it has been found in sub-zero temperatures that an oxy-acetylene flame destroyed the hatch cover paintwork, but gave patchy adhesion.

Despite all the foregoing practical difficulties, the use of high adhesive sealing tape seems to be considered by cargo interests to show that the ship has made every effort to protect the cargo, whilst failure to use the tape is criticised in cases of wet damage to cargo as a neglect of seamanlike precautions. The use of high adhesive sealing tape is fairly common with sensitive cargoes such as grain, steel and woodpulp, hut it must be stressed that the effectiveness is doubtful, the damage which it can cause to the hatch covers in the long term is substantial, and it can never be a substitute for ensuring that the covers are maintained to good standard.

Plastic sheeting spread over cargo surface: Plastic sheeting can be spread over the surface of a bulk cargo and, provided that adjoining sheets are spread in the same manner as the tiles on a roof with the higher sheet overlapping the lower one, any water which falls on to the sheeting will run to the sides or ends of the hold. Such an arrangement will catch leakage through the hatch covers and also any condensation which falls from the deckhead on to the cargo.

When the sheeting is removed, it mav be possible to remove within the sheeting any water which has been caught in the 'trench' at the ship's side or at the end bulkheads, thus reducing or eliminating wet damage to the cargo. Any leakage which does reach the cargo, will damage cargo at the boundaries of the hold. Damaged cargo is likely to be rejected by the receivers. The cargo in the hatch square will be undamaged and can be grabbed directly out of the hold. The cargo at the hold boundaries is less accessible and is therefore less likely to be grabbed directly out of the hold. The damaged portions can more easily be sorted during the mechanical or manual stages of the discharge within the hold, particularly if the commodity is one which cakes when wet.

This system is used in the transportation of chemical fertili/er from Sweden to Belgium in winter, a voyage during which the ambient temperature increases, so that the outside water and air become warmer than the cargo in the hold. In these conditions cargo sweat (condensation taking place directly on the cargo) is likely to be formed. If the cargo is covered with plastic sheeting the sweat will form on the sheeting rather than on the cargo, thus preventing the caking which occurs very readily with this commodity.

The use of plastic sheeting in this manner is not suitable for cargoes which require surface ventilation. In addition it may cause condensation to form beneath the sheeting, and to form a caked surface layer on the cargo in circumstances in which ship's sweat is to be expected. Such circumstances occur when the cargo is a warm one, being brought to a cool climate.

Sources

1. Lockhart, R. G., 'Hatch Cover Design & Related Experience', Lloyd's Register of Shipping. Joint Conference on Hatch Covers-Design, Installation. Operation &; Maintenance. Marine Media Management Ltd, January 1977.

2. Turnbull, D. E., 'Maintenance, Overhaul and Repairs to Hatch Covers'. Joint Conference on Hatch Covers-Design, Installation, Operation & Maintenance. Marine Media Management Ltd, January 1977.

3. Goklie, C. W. H., The Views of a P&I Club Manager'. Joint Conference on Hatch (-overs-Design, Installation, Operation & Maintenance. Marine Media Management Ltd, Jamiarv 1977.

4. Bisset, A. & Hill, B., 'Some Typical I latch Cover Defects in a Mixed Fleet'. Joint Conference on Hatch Covers-Design, Installation, Operation & Maintenance. Marine Media Management Ltd, January 1977.

5. Pitt, Captain C. T, OBE, 'Some Practical Experience with Steel Hatch Covers'. Joint Conference on Hatch Covers-Design, Installation, Operation &; Maintenance. Marine Media Management Ltd, Januarv 1977.

6. van Havre, J., 'Comments from a Cargo Surveyor & Adjuster'. Joint Conference on Hatch (-overs-Design, Installation, Operation & Maintenance. Marine Media Management Ltd, Januarv 1977.

16. 'Care and Survey of Hatch Covers of Dry Cargo Ships'. The International Association of Classification Societies. *Work of the Nautical Surveyor.* The Nautical Institute. 1989.

27. Bnxton, I. L. Daggitt, R. P. King, J, *Cargo Access Equipment for Merchant Ships,* E. and F. N. Spon Ltd, 1978.

36. Croall.J., 'The Testing of Hatch Covers Ultrasonically: A Time Saving Technique'. *P&I International,* Vol.5 No.2. February 1991.

39. MacGregor-Navire Technical Data Sheets Nos. 8 (4/85), 10 (11/85), 11 (11/85), 12 (11/85), 13 (7/85), 14 (3/89).

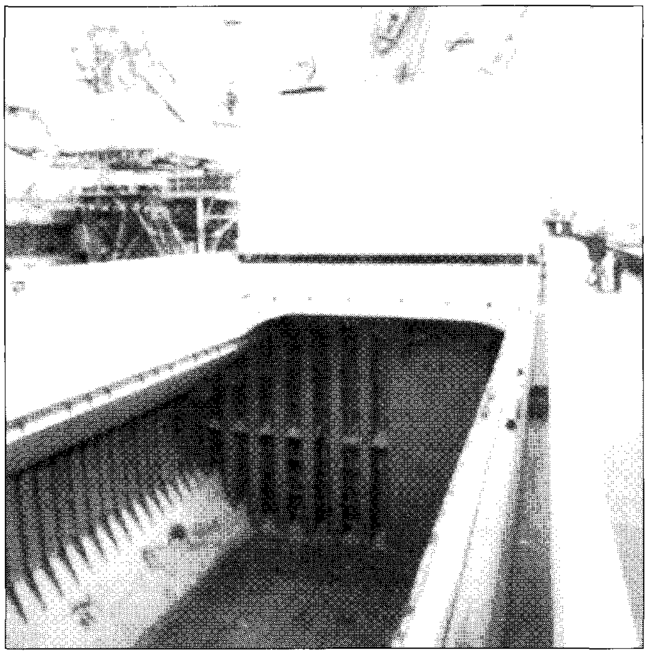


FIG 4.22 THE COMPRESSION BAR

CHECKLIST-Procedures for maintaining hatch covers in efficient condition

- ☐ Study the manufacturer's literature and gain a full understanding of the operating and maintenance procedures.
- ☐ Ensure that all hatch drain holes are clear.
- ☐ Clean coamings and cross-joints very thoroughly before closing hatches.
- ☐ Do not move hatch panels if spilt cargo is piled on them.
- ☐ Close panels in the correct sequence.
- ☐ Ensure panels are correctly positioned before securing them.
- ☐ Fasten cleats in the correct sequence.
- ☐ Officer to inspect secured hatches before proceeding to sea.
- ☐ Hold stevedores responsible for hatch damage, and have damage repaired.
- ☐ Carefully supervise hatch opening and closing when crew members are inexperienced, tired or working in difficult conditions.
- ☐ Avoid moving hatch covers when the ship is pitching or rolling.
- ☐ Whenever possible avoid opening hatch covers at sea.
- ☐ Inspect hatches regularly for items which are worn, slack or corroded and renew, repair or adjust them as necessary.
- ☐ Grease hatch fittings regularly.
- ☐ Ensure that all moving parts can be greased: fit nipples if needed.
- ☐ Protect hydraulic pistons before painting hatch coamings.
- ☐ Paint behind hydraulic pipework, or wrap it with Densotape.
- ☐ Give high priority to scaling and painting of cross-joint channels.
- ☐ Carry sufficient spares to permit emergency renewal of any fitting.
- ☐ Carry a good supply of spares for routine renewals.
- ☐ Ensure that equipment required for the emergency opening and closing of hatch covers is kept labelled and readily available.

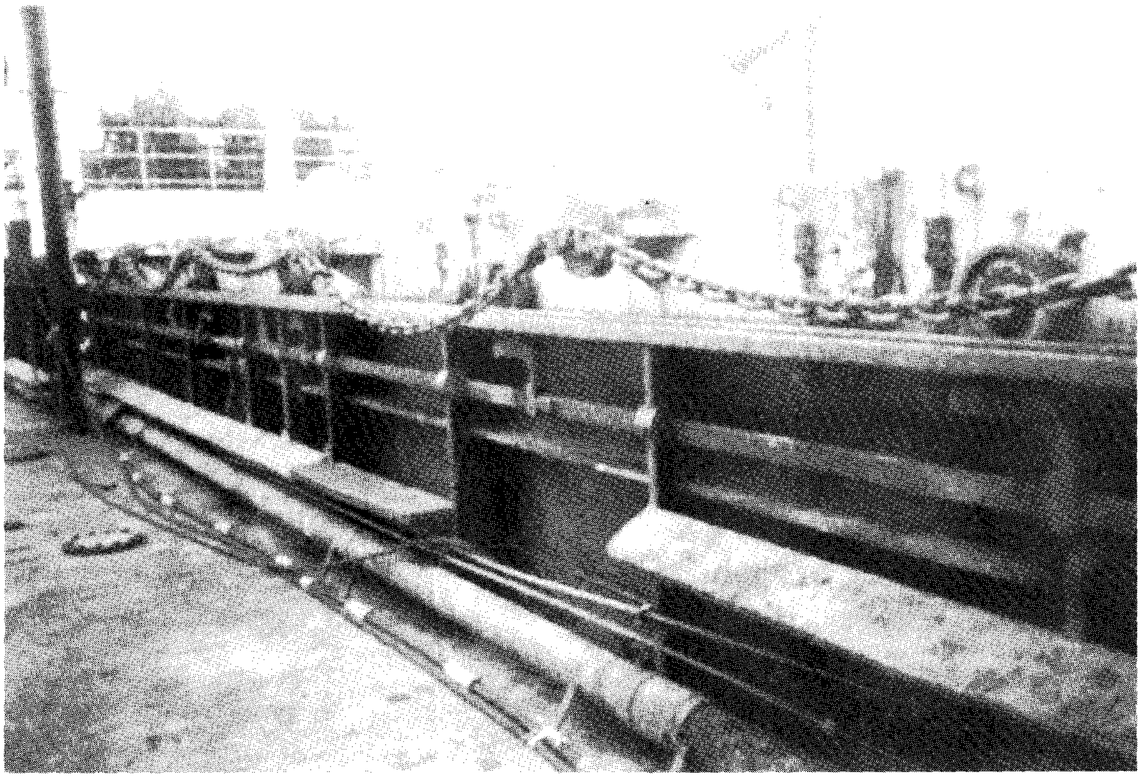


FIG 4.23 BADLY ADJUSTED CONNECTING CHAINS

CHAPTER 5

PREPARATION OF HOLDS

General considerations, disposal of cargo residues, preparation for cleaning, washing, clearing blocked bilge suctions, drying, sweeping, preparation of bilges and testing of fittings, hold inspections, time required for hold preparation, final preparations, hold coatings, ballast holds

Cleaning of holds-general considerations

WHAT cleaning is needed?: When the discharge of a hold is completed, the chief mate will need to decide how, when and if the hold is to be cleaned. Holds should always be cleaned in preparation for the next cargo except when the ship is engaged on a shuttle service carrying the same cargo. For example, on a coastal service carrying coal between two Danish ports the charterers found it cheaper to send the ship from the discharge port without employing trimmers to discharge the final sweepings. Turnround time was reduced by two hours and the cost of employing trimmers was avoided.

Similarly, a ship engaged on time charter for the carriage of iron ore may not clean the holds between cargoes, even if different grades are carried, though the holds will be 'shovel cleaned' by shore labour *in* the discharge port. When a ship is on vovage charter, the normal requirement is for the holds to be cleaned ready for any cargo, or for the particular cargo intended next voyage.

When on time charter it is advisable to ask charterers what they require by way of hold cleaning since charterers understandably object to paying the owners for a wash costing US$1,000+ per hold when all thev require is a sweep, which is often free.

Need for complete discharge: Cleaning the holds will be much more difficult if quantities of cargo sweepings have been left in the hold, particularly if the cargo is not soluble in water, so the ship's officers will do all that they can to compel or persuade the stevedores and trimmers to discharge all the sweepings. If a bilge cover plate has been displaced and cargo has filled the bilge, the trimmers will be unwilling to remove it. If they cannot be induced to do so it will be worthwhile to send the crew to get all the cargo out of the bilge before the finish of discharge, so that the contents of the bilge can be discharged along with the rest of the cargo.

Stevedores are often willing, if asked, to return to a hold where discharge has been completed, to remove sweepings gathered by the crew. They may even be prepared to leave a grab resting in the hold for a while tor sweepings to be shovelled into. On a gearless bulker such help is very welcome.

System for removal of water from holds: Bulk carriers are usually provided with a bilge suction svstem, which uses a pump or an eductor in the engineroom to extract water from the holds. The water is drawn through the bilge lines to the engineroom and discharged overboard. Such a bilge svstem is usually operated with the same pump or eductor as is used from stripping ballast, a process described in Chapter 7.

Such a system cannot be used to wash large particles (if cargo out of the holds as cargo residues will clog the suctions, non-return valves and bilge lines. The holds must be swept very thoroughly and the cargo residues must be lifted out of them before the holds are washed.

An alternative arrangement, found in some bulk carriers of all sizes, is the fitting of port and starboard bilge eductors in each hold. These eductors discharge directly overboard through discharges at deck level. There are no filters or non-return valves in the lines, which can discharge lumps of cargo the size of apples provided that the diameter of the discharge line is sufficient. As a result, thorough sweeping and removal of residues is much less necessary.

From the foregoing it is obvious that, when preparing to clean holds it is necessary to know which type of water removal system is installed.

Nature of cargo residues: Soluble cargoes such as salt will normally present no problems for hold washing, and sweepings of granular cargoes like olivin sand or concentrates can usually be washed away without difficulty provided that the pressure of the washing water is maintained at 7 kg/cm- (100 psi) or better, and that the holds are drained by a direct overboard discharge bilge eductor system rather than a bilge pump system. Where cargoes come in larger lumps, like quart/, for example, it is particularly important to ensure a complete discharge of the sweepings since remnants cannot be drained from the holds and will have to be lifted out by the crew.

Disposal of cargo residues and associated waste

The Marpol regulations[93] and national and local regulations govern the disposal of cargo residues and determine whether they are released at sea or landed in port. These matters are discussed in Chapter 25, while in this chapter each of the alternative procedures is described.

Alternative methods of disposal: Most cargo residues are washed from holds, the washings being discharged into the water alongside the ship. When residues cannot be washed from holds they must be lifted from the holds for later disposal. A geared bulk carrier equipped with her own derricks or cranes will be able to use them if necessary to lift sweepings from the holds, provided that the ship is steady enough to permit the use of the ship's gear. The same considerations apply to a mobile crane, such as is carried aboard some large bulk carriers. If the weather is rough or if the ship is gearless and has no mobile crane, it will be necessary to use a mucking winch (described in Chapter 22, and sometimes known as a sediment hoist) and davit fixed to the hatch coaming, or access or trimming hatch, to raise-sweepings from the hold.

Use of mucking winch: A mucking winch and the seamen who use it can only handle small quantities of sweepings-for example, a full bucket or 20 litre drum-at a time. The container is filled in the hold and earned to a position below the mucking winch where it is hooked on and raised to deck level. It is swung clear of the hatch coaming and landed on deck where it is immediately tipped over the ship's side, or is emptied on deck for later disposal, depending upon the nature of the sweepings and the location of the ship. Sweepings can be tipped on deck in front of an open hydrant, where the water from the hydrant can be used to wash them overboard. Inexperienced crew members must be reminded to tip or wash the sweepings over the lee side!

Sweepings left on deck: If the sweepings have to remain on deck they present problems for the ship, since residues arc liable to be blown about the ship by the wind and they may stain the deck and the ship's side. For this reason they should be retained in the hold until such time as it is possible to tip them overboard. When this is not possible the sweepings should be stowed on deck in drums. On larger vessels where the quantities involved are too great for the use of drums, the sweepings are usually stowed between hatches and slightly dampened down to prevent them from being blown around the ship. Lifting of sweepings from the hold is a labour-intensive and potentially dirty process. It is always preferable for the ship to dispose of residues by washing, and this method is adopted whenever possible.

Sweepings left in hold: If it is not possible to remove sweepings from the hold before arrival at the loading port because of adverse weather or because of the weight and volume of the sweepings, they should be piled in an accessible part of the hold, in drums or sacks if possible, ready for rapid removal upon arrival. In the rare cases when this is done, it will be necessary to give owners or charterers maximum warning to ensure that facilities are ready on arrival and offhire time and costs are minimised.

Preparation for hold *cleaning*

Man\' ships' officers have experienced the embarrassment of finding cargo residues on the tanktop when the hold is opened in the loading port, although a thorough hold cleaning, and inspection, have previously been undertaken. This can occur when full astern is ordered in the approaches to the berth, and the resulting vibration shakes down traces of old cargoes from inaccessible and undetected surfaces high under the deckhead.

To reduce this problem, some masters put the engine to full astern, allowing the ship to vibrate and shake down the residues at the start of the ballast passage, before the holds have been cleaned. Even when this is done, it is prudent to reinspect all the holds a few hours before the loading port is reached, so that any unexpected problems can be found and corrected before loading is due to commence.

When discharging sticky cargoes such as grain, it is often worthwhile to send crew members into the holds to clean positions high under the deckhead during interruptions in discharging. Whilst standing on the cargo during early stages of the discharge they can reach places that later become inaccessible. Such work must always be carefully supervised to guarantee the safety of crew members.

Washing holds

Handheld hoses: The normal method of cleaning holds is by washing with water drawn from the sea. This involves hosing down every part of each hold with a water jet whilst the water is drained from the hold by the eductors or bilge pumps, and discharged overboard. Three alternative methods of hosing down the holds exist-using handheld hoses, water cannon, or a permanent installation.

The hosing may be done by handheld hose operated by a team of two or three seamen. One will be on deck to operate the control valve where the hose is connected to the deck service line (or fire main) and will oversee operations, whilst the others will drag the hose around the hold and direct the jet at each part of the compartment in turn.

On larger vessels it is important to use at least two men to handle the hose, since one will be unable to control the hose at full pressure and will do a poor job, either because the hose has been badlv directed or because the pressure has been reduced. Aboard a small ship with holds which arc not particularly dirty, a handheld hose is often the quickest and best method of completing the job. Handheld hoses are less satisfactory in larger ships-it is difficult to achieve good cleaning in the more remote parts of the hold and the method requires a lot of time and labour.

Water cannon: An alternative to using a handheld hose is to have the hose led to a high-pressure sea-water cannon, such as the Combi-gun, on a tripod placed in the hold. The Combi-gun uses compressed air from the ship's deck line to inject greater pressure into water from the fire main. This system, more likely to be used on larger bulk carriers, provides a more powerful jet of water than can be achieved with a handheld hose and results in better cleaning of the high extremities of the holds. The system takes longer to move from place to place and requires as much labour as does the handheld hose.

The washing sequence adopted when washing with handheld hoses or water cannon starts at the top of the hold and works towards the bottom. First, hatch covers are washed on all sides, as far as possible. Compression bars and rubbers may need scrubbing to remove cargo which is sticking to them. Next, the coamings, hold deckheads and hold sides are washed, paying particular attention to non-vertical surfaces such as hopper angles, pipe guards and brackets. Finally, the deck is washed and the bilges are flushed.

Permanent installation: The third option for washing the holds is to use a permanent washing installation with water guns installed under the deck-head in the hold. Aboard a mini-bulker the hold would be equipped with one water gun at each end. Each gun is wound down into the hold from a recess in the deckhead. Water at high pressure is provided by direct line from the engincroom. If the full washing programme is selected, the gun will then automatically move through a full washing sequence with the hose directed first upwards to the deckhead, then more or less horizontallv on to the bulkheads and finally downwards towards the tanktop. Alternative washing programmes can be selected. A bottom wash is a wash of the tanktop only. The programme is designed to wash towards the after end of the hold, where the bilge suctions are located.

Water must not be allowed to stand: All of **the** foregoing systems of washing depend upon the flow of water to wash any dirt and residues down the bulkheads and across the tanktop to the bilge stictions. If the washing is to be effective, it is preferable that the water is pumped or educted from the holds continuously and that no pool of standing water is allowed to form on the tanktop. Whilst in ballast the ship will normally have a good stern trim, causing the water to flow across the tanktop and thereby assisting the washing process. On some ships the washing is found to be most effective if the ship is listed 1° with ballast water; if one bilge suction becomes blocked, the ship can be quickly listed the other way, allowing the use of the other suction to pump out the water. This will permit access to the blocked suction to clear it.

An exception to the foregoing occurs when it is necessary to wash holds in port because of lack of time, but the washings cannot be pumped overboard in port. In these circumstances the washings can be left in the hold to be pumped out when the vessel reaches the open sea. This procedure is often adopted with the ballast hold and can be followed with another hold, provided that it is safe to do so. It will be safe only provided that the water in the hold remains at a low level, say, up to one metre, and provided that calculations show that the ship's stability will remain adequate despite the reduction in metacentric height (GM) from the free surface of the water. The required calculation is described in Appendix 8.1.

Washing stubborn dirt: When the holds are washed after particularly dirt}' cargoes such as petroleum coke (petcoke), the washing time will be extended in an attempt to achieve a satisfactory standard of cleanliness. If it is found that greasy or discoloured patches remain they will be hand scrubbed with detergent by crew members, or washed with a portable high-pressure washing machine before the entire hold is again washed.

Certain exceptional cargo residues must not be washed at all. It is reported, for example, that copper concentrate, if washed, will form a 'concrete' layer on the hold sides which can only be removed with abrasive discs on disc sander/grinders. This cargo must be cleaned by thorough blowing with compressed air and by sweeping.

Fresh water rinse: When holds are washed with sea water, traces of salt remain on all the surfaces within the hold. This is unacceptable to some grain surveyors and is liable to contaminate cargoes such as steel products and woodpulp. Salt traces will also encourage corrosion and are to be avoided if possible"". For these reasons holds should be rinsed with fresh water after full washing. One method of achieving a fresh water rinse is to load fresh water in a suitable ballast tank, such as the forepeak or afterpeak, and then to pump the fresh water through the deck service line for use in hosing down the holds.

When using this method it is important that the crew members operating the hose understand that they are using fresh water and not the sea water which normally runs through their hoses. The water must be used efficiently and with care to provide a quick rinse of each compartment if all holds are to be properly washed with the available supply of water. On a handy-sized vessel such as the *Regina Oldendorff*, where the fire pump has a capacity of 200 tonnes/hour, two or three minutes spent rinsing each hold with fresh water will use a total of 50 tonnes for the entire ship and should remove most of the salt from the structure. An alternative method of fresh water rinsing is to use a portable high pressure washing machine. This will use less fresh water, but will take much longer.

Fresh water has a cost in most ports, so, if sufficient water for hold rinsing cannot be generated aboard ship, care should be taken to ensure that water for hold washing is obtained where it is cheap or free, the best sources of supply being those few places where the ship floats in clean fresh water. When appropriate the receipt for fresh water should be claused 'Hold Washing-For Charterer's Account', as it is the accepted practice in some trades for charterers to pay for fresh water washing when required for cargo purposes.

Fresh water washing of holds is recommended, but is done less often than should be the case because of the short-term cost in labour and fresh water, and because the benefits of reduced corrosion and reduced cargo contamination are not immediately apparent.

Hand hosing of holds only in sheltered waters: Washing of the holds with handheld hoses is most easily achieved with the hatch covers open and normally commences with a hosing down of the hatch coaming top and the undersides and cross-joints of the open hatch covers. Such washing can only be carried out in sheltered waters or in calm sea conditions, since mechanical steel hatch covers are likely to be damaged if opened or closed when the ship is pitching or rolling.

Precautions when washing within port limits: In an increasing number of ports"' hold washing within the port limits is prohibited since the port authorities do not want cargo residues discharged into their waters, regardless of whether or not the commodity in question is a harmful or offensive one. If there is doubt as to whether hold washings can be discharged in port, it is prudent to obtain written permission via the agent. A spoken assurance from a stevedore is no guarantee that the ship will not be penalised later.

When hold washing is permitted at the berth it is usually necessary to discharge the washings only on the offshore side of the ship to avoid flooding the jetty. If hold washing is permitted within the port, arrangements must be made aboard ship to ensure that discharge of washing water can be stopped immediately if a pilot boat or other craft has reason to approach. This will ensure that accidental flooding of a boat can be prevented.

Hand hosing of holds is difficult at sea: If holds are to be washed at sea with handheld hoses, the process can be carried out most safely by leaving the hatch covers closed and passing the hose down the access hatch. Unfortunately this makes manipulation of the hose more difficult and provides poorer lighting. It also interferes with easy communication between the members of the washing party. In these circumstances there arc strong reasons for opening the hatches 1 metre, if no more. Since the ship will be in ballast with a large freeboard, there is normally no realistic clanger of foundering as a result of opening hatches. The danger lies in the hatch covers suffering damage whilst they are unsecured, as a result of the ship working in a seaway.

Hatch covers should never be opened at sea, except in calm conditions, and the hatches when open must be well secured. If conditions start to become rough whilst hatches are open, the vessel must be hove-to to provide a steady platform whilst the hatches are closed.

Use of permanent installations at sea: Permanent washing installations are designed to be tised with the hatches closed. There is no problem in using them when the vessel is at sea.

Clearing of blocked bilge suctions

One suction blocked: Prevention is better than cure, and the blocking of bilges can be avoided by sweeping of holds and lifting of sweepings prior to washing and by the use of bilge baskets to catch larger lumps of cargo residue. Portable bilge baskets (which can be manufactured aboard if not provided-Fig. 5.1) are perforated steel boxes which are temporarily placed in the bilge wells to collect sweepings. They must be emptied regularly during hold washing. This is easily done during a manual wash and can prevent problems with blocked bilges and bilge lines.

PORTABLE BILGE BASKET

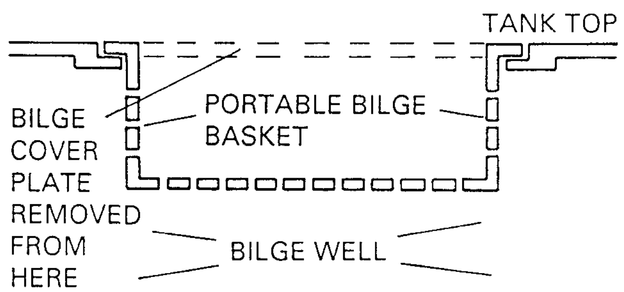


FIG 5.1

BILGE COVER PLATE

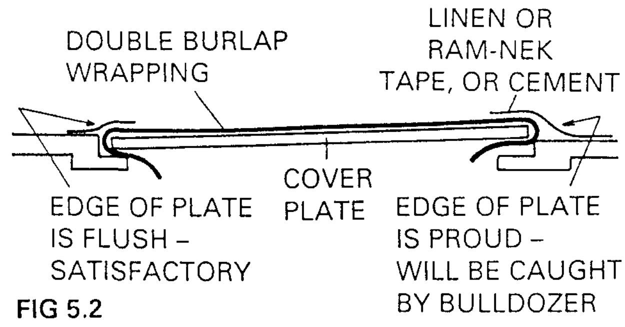


FIG 5.2

Hold washing should be monitored at all times to detect any build-up of water. If such a build-up occurs, washing operations should immediately be stopped and the problem investigated. Directing a high-pressure hose into the bilge may be sufficient to clear the suction. Alternatively, if it is a hold eductor suction which is blocked, then 'flooding back' may be the quickest way to clear it. This is achieved by temporarily shutting the eductor discharge so that the water which drives the eductor is forced through the bilge suction into the hold.

If the tanktop becomes flooded as the result of a single blocked suction, the hold can be pumped out by way of the other, with the ship given a small list towards the clear suction. Since the blocked suction will be located within a bilge well, and since the bilge well is likely to be from 1-2 metres in depth, it will be necessary to remove most of the water from the well before the suction can be cleared. If the bilge well is small in volume it is possible to bale it out with buckets, but if the bilge well is a large one a portable sump pump, powered by compressed air or water at high pressure, will have to be lowered into the hold and led to the blocked bilge where it will be used to pump the water across to the clear bilge.

Next, it will probably be necessary to unbolt one or more sections of the suction pipe to locate and remove the blockage, and make the suction ready for use again.

Both suctions blocked: If both suctions are blocked and the water is lying in the hold to some depth, a more serious problem exists. Portable sump pumps may be able to remove the water but the requirement to pump the water the full height of the hold for discharge on deck may mean that the process is a slow one, or that it proves to be impossible. One alternative in these circtimstances is to open a manhole cover in the tanktop at the forward end of the hold to allow the water to drain into a double-bottom ballast tank. This can be done provided that the water at the forward end of the tanktop is not too deep to allow access to the manhole cover, and provided that the water drained into the double bottom will not contaminate it.

Drying of holds

The charterparty frequently requires holds to be presented 'Clean and Dry', and the requirement for a dry hold is not always easy to meet if the ballast passage is short and the hold has just been washed, or if sweat is forming in the hold. Holds can be dried by ventilating them when weather conditions are favourable and this is a useful test of the cargo ventilation fans. Some ships are provided with ventilators for natural ventilation but not with cargo ventilation fans, and ships on bad weather routes may have the ventilators unshipped and blanked off. Two steps can still be taken. The crew can mop up all the puddles which form in the depressions in the tanktop when a hold is washed. If the weather is dry the hatches can be opened when the ship reaches smooth waters in the port approaches, and the flow of air over the ship will help to dry the holds.

It is clear that the requirement for a dry hold is unnecessary when the intended cargo is stored in a stockpile in the open air exposed to the weather, and shippers will normally be realistic and raise no objections if the hold is damp on arrival. This is not a reason to permit puddles of water in the hold and holds should not be presented for cargo in such a condition.

When commencing the loading of a cargo of grain in winter with holds which are sweating, it may be possible to persuade the operator of the grain elevator to blow some grain dust into the hold. This will stick to the moisture and will coat the hold, thereby reducing the contact between grain and moisture.

Sweeping of hofds

Sweeping of holds when washing is not permitted: There are at least three situations in which hold washing is not required or cannot be carried out. If a ship is required to backload a bulk cargo in the same port as that in which she discharges, and if hold washing in the port is not permitted, it will be necessary to achieve the required standard of cleanliness by sweeping and then lifting the sweepings out of the hold to be stowed on deck until such time as they can be landed or disposed of legally at sea. This is work which the crew will be expected to do if time permits, so the chief mate will make every effort to ensure that the stevedores complete a good discharge and leave the minimum of sweepings in the hold. Shore labour must be employed for cleaning if there is insufficient time for the crew to complete the work before loading is due to commence. The quality of the required cleaning will depend upon the intended cargo and the danger of contamination, but as a general rule it is unreasonable to expect a very high standard of cleaning if washing is not permitted.

Sweeping of holds when washing is not necessary: Washing will probably not be required following a clean cargo such as steel coils or steel slabs. It will be sufficient to sweep up any debris and remove it from the hold.

Sweeping of holds in freezing conditions: Washing cannot be tindertaken in freezing conditions. When the temperature is below freezing and the water is brackish, as it is in the Baltic and approaches, washing water will freeze on bulkheads and coamings. In these circumstances holds can only be scraped and swept clean, with all residues including ice having to be lifted from the hold. If early warning is given, massive fan heaters can be hired in some Baltic ports to dry out holds if the ship arrives with a coating of ice in the holds to load a sensitive cargo such as chemical fertilizer. The heaters are normally connected to a shore power supply. A mobile crane will be needed to place the heaters in the hold if the ship does not possess her own derricks or cranes and if there is no permanent crane at the loading berth.

Sweeping of holds in preparation for washing: Holds should be swept and the sweepings removed whenever the stevedores will accept and discharge the sweepings before the vessel sails from the discharge port. In addition the holds should be swept before washing, except when the residues are soluble or when hold eductors which can remove the residues are fitted.

Preparation of *bilges* and *fittings*

Cleaning of bilges: When hold washing has been completed, consideration must be given to cleaning of the bilges. Bilges are cleaned to ensure that they continue to function properly and do not become blocked with residues. In addition, they must be meticulously cleaned with every trace of matter removed and mopped dry, if foodstuffs such as grain or sugar are to be carried. Before carrying grain or other foodstuffs, the bilges should be sprayed with insecticide and rinsed with disinfectant. When presented for inspection they must be clean, dry and sweet smelling.

A bulk carrier bilge well normally consists of one or two bays of double bottom space, anything from 2 m^3 to 10 m' in volume. The space is usually cramped and uncomfortable to work in. Any accumulation of cargo should be removed and, when hold eductors are fitted some of this can be achieved during the final stages of manual hold washing by a man standing over the bilge well and stirring the contents with a broom, so that the maximum is drawn away through the eductor.

Whatever remains in the bilge must be dug out with a hand shovel and lifted out of the hold by one of the processes described earlier. Traces of perishable cargoes must never be left in the bilges; they will decay and decompose, often with most unpleasant smells. On ships where the bilges are emptied with a bilge pump, each bilge suction is usually fitted with a perforated strum box to prevent large particles of cargo from entering the system and blocking the pump strainers. The strum boxes must be taken apart, cleaned and refitted.

Flushing of sounding pipes and thermometer pipes: Hold bilge sounding pipes extend from the weather deck to the bilge wells in the hold, there normally being one on each side, port and starboard. Hold bilge sounding pipes are essential for the detection and measurement of any water in the holds, even when remote gauges or alarm systems exist as well. Sounding pipes must be fit to be used when required; they must be kept clear at all times. It is regrettable that numerous instances can be quoted to show that sounding pipes are neglected and become blocked and unusable. This usually happens as a result of cargo residues being left in the bilge well and entering the bottom of the sounding pipe where, over a period of time, they dry out and solidify.

This problem can be prevented if the sounding pipes are flushed out-i.e., hosed out with water from deck level after the hold has been washed and the bilge has been cleaned. This should be done as routine, with the water being removed from the bilge well by eductor or bilge pump. Some operators use an air line instead of a hose to flush out sounding pipes, sealing the mouth of the pipe with rags wrapped around the airline. The same alternatives are available for the flushing of hold thermometer pipes, which must also be kept clear.

Testing of bilge suctions: If the hold has been washed out and the washing water has been discharged by eductors or hold bilge pumps, there will be no need for further testing of the hold bilge suctions. If the hold has only been swept or has not been cleaned at all, it is necessary to test the bilge suctions to ensure that water can be pumped out of the hold during the voyage if that becomes necessary. The testing of the bilge suctions can be combined with the flushing of the sounding pipes. Putting the water down the sounding pipe into the bilge well confirms that the pipe is clear, and pumping the water out of the bilge well confirms that the bilge pump or eductor is working satisfactorily.

The correct working of the non-return valves fitted in the hold bilge-to-cngineroom lines (but not in the lines of hold bilge eductors which discharge directly overboard) can be tested by stopping the bilge pump or bilge eductor in the engineroom, and allowing water to flood back through the bilge line. If none enters the hold bilge the non-return valve is working corcctly. High level bilge alarms, when fitted, must be tested by raising the float and obtaining confirmation, usually by walkie-talkie radio, that the alarm has sounded.

Hold inspections

The chief mate is responsible for ensuring that the holds are ready for cargo, and will normally inspect the holds himself when preparations are reported to be complete, if not before. If the crew members take an interest in their ship, it is quite likely that damage and defects noticed by crew members will already have been reported to him. The amount of supervision for the whole process of cleaning will depend upon the experience of the crew as well as their attitude.

During the ballast passage, loose scale may form in a cleaned hold, leakage into the hold from a ballast tank may occur or undetected cargo residues may fall from high in the hold. It is prudent to reinspect the holds at the end of a ballast passage, some hours before the vessel reaches the loading berth, to allow time for correction of any new problems which may have developed during the passage.

Cleanliness: The chief mate's first concern will be for hold cleanliness. If he has been instructed, or has read, or knows that the next cargo requires a particularly clean hold, he will inspect flat surfaces high in the hold, stich as the flanges of beams visible from the hold ladder, for signs of cargo residues which must be removed. When at tanktop level he will find whether the bulkheads, hopper sides and tanktop are clean to the touch. He will look for residues beneath manhole cover plates and behind pipe casings. The bilge wells must be inspected. If the chief mate finds any fault he will know that a surveyor could use it as a reason to reject the ship for a sensitive cargo, and he will ensure that further washing or local cleaning is carried out to remove the fault.

Rusty steelwork within holds is not a reason for rejecting a ship in normal bulk trades, but loose (rust) scale is not acceptable as it is likely to mix with the cargo and contaminate it. Loose scale should be removed by scraping and/or high pressure washing.

Insect infestation: Any trace of insect infestation in the hold or in the bilges is unacceptable with an edible cargo. The owners should be consulted as soon as possible for advice about the best way of eliminating the insects without making the hold unusable for the next cargo. Spraying with a suitable spray ma)' be sufficient, or the hold may have to be fumigated (see Chapter 21).

Loose scale is a favourite hiding place for insects (otherwise known as bugs), and the inspection for them should be very thorough before perishable cargoes are carried. If detected by the inspectors, insect infestation can result in expense, delay and offhire whilst the ship is fumigated. If they are undetected, there is a danger that the cargo will be damaged and massive cargo claims will be experienced.

Leakage from ballast tanks or other sources: This is probably the most favourable time to detect leakage from ballast tanks since such tanks will be full. Leakage from ballast tanks is a regular problem with middle-aged bulk carriers. Even if the leakage is minor it is still inconvenient. Ballast must be discharged from the leaking tank before any cargo is loaded, to avoid wet damage to the cargo, and this may be inconvenient. It will also be impossible to present dry holds at the loading port, except by keeping the ballast tank empty. If the leak is a major one it will be easy to detect. It will cause an additional difficulty; as water drains from the leaking tank into the hold the ship will develop a list.

When leaks are found, the chief mate will note their position with great care for subsequent repair and will arrange to pump out or drop out the ballast from the leaking tank as early as possible before arrival.

Hold damage: The hold should have been checked for damage during discharge and again upon completion, but when the hold is dirty it is still possible for damage to be overlooked. The chief mate will inspect for damaged hold ladders, airpipes, thermometer pipes and sounding pipes and their casings, and damaged piping for any hold smothering system which is fitted. Local workers in many parts of the world insist that hold ladders, with platforms, handrails and protective hoops, are to be in perfect condition. It is sensible to make sure that all is safe for the ship's crew, too, if accidents are to be avoided.

Damage to frames, brackets and plating should also be recorded so that new damage can be shown to be the responsibility of the correct port and/or the charterers. The chief mate will also satisfy himself that no cover plates for manholes or gratings for bilge wells are missing.

Time required for hold preparation

The time required to clean a hold and prepare it for cargo will depend upon the dirtiness of the previous cargo, the volume of residues, the size of the hold, the resources available for cleaning, the standard of cleanliness required, and the number and experience of the seamen available. A reasonable estimate is that it will take three-four men one day to clean one hold of a handy-sized or Panamax bulk carrier to normal cargo-ready standard from time of first entering the hold. Cleaning to grain standard will take longer.

Cleaning of a hold of a mini-bulker and preparing for loading can normally be achieved by two or three men, to a grain-ready standard, in four-five hours, whilst a routine hold wash and rinse of the bilge wells can be completed in one-two hours. It is normally only possible to wash one hold at a time, though other tasks in an adjacent hold can be completed whilst the hold is being washed, if sufficient labour is available.

Final preparations

Burlapping of bilges: Bilge wells are usually provided with cover plates consisting of gratings or robust steel perforated plates set flush with the tanktop. (Fig. 5.2) They are designed flush with the tanktop to reduce the likelihood that they will be dislodged by the bulldozers which will be used to shovel cargo into the centre of the hold in the later stages of discharge. These plates or gratings for drainage are intended to admit water from the hold to the bilge well and to prevent large particles of cargo from falling into the well.

Smaller particles of cargo can still fall into the bilge well so whenever dry bulk cargoes are to be carried it is normal practice to line the bilge cover plates with burlap (sacking or gunnysack). This is achieved by wrapping the burlap around the cover plate, replacing the plate in its normal position and then sealing the edges of the burlap with cement or with Ram-nek or linen tape. After the fitting of the burlap the cover plate must remain flush with the tanktop. If the burlap is badly fitted and raises the cover plate proud of the tanktop (Fig. 5.2) it is likely that the plate will be dislodged, the bilge well will fill with cargo residues and the cover plate may be discharged by mistake.

Resealing of manhole covers: Double-bottom tanks are located beneath the cargo holds and they normally contain ballast water or fuel bunkers. The access to each tank is by manholes set into the tanktop in the hold, though larger bulkers have additional manholes in the stool spaces. Each manhole is closed with an oval steel lid fitted with gaskets and secured with nuts, tightened on studs. The lid will fit either directly above or directly below the manhole opening, according to design. To ensure that cargo cannot be damaged it is essential that when a manhole lid is closed a watertight and/or oiltight seal is achieved.

Such a seal is achieved by using a gasket which is in good condition, and by ensuring that the gasket and the steel surfaces of manhole and manhole lid are all absolutely clean, smooth and free of particles of rust or cargo. When this has been ensured all the nuts must be tightened hard. When closing of the manhole lid has been completed the tank, if a ballast tank, should be pressed up (i.e., filled to overflowing) to test whether the closed manhole leaks.

It is not prudent to press up a fuel tank, except by gravity, because the consequences of an overflow would be so disastrous, so it may not be possible to pressure test the manhole lid of a fuel tank. For that reason it is all die more important to ensure that the lid is fitted carefully and expertly if there is reason to open it. Fortunately, reasons for opening fuel tanks are much more rare than are those for opening ballast tanks.

When a manhole lid is in place, a portable steel cover plate, flush with the tanktop, is normally provided to protect the recess. If the cover plate is in place it should be unshipped and any residues found beneath it should be removed. Grain has been seen sprouting from beneath these plates! During discharge it is easy for the cover plates to become dislodged and lost. If they are not fitted the manhole and its nuts and studs are in danger of being damaged. One method for protecting them if the cover plate is missing is to clean the recess thoroughly, spread old cloth over the nuts, and then fill the recess with cement, smoothed off flush with the tanktop. The purpose of the cloth is to prevent the cement from setting hard onto the nuts. Cement mixed to a strength of three parts sand to one part cement is suitable. When the manhole cover has next to be opened, the cement can be removed with a power chisel or with a cold chisel and mallet.

Isolation of electric circuits: If the intended cargo can burn or gives off gas which might explode, then any electric circuits such as hold lighting or forced ventilation circuits which pass into or through the holds or adjacent compartments should be isolated. In the case of cargoes which give off gas, the precaution must be extended to masthouses and other compartments connected in any way to the holds by access hatch, ventilator, or sounding, air or thermometer pipe. The most effective and reliable way of isolating such circuits is to remove their fuses.

Hold coatings

Limewashing: The shippers of most cargoes will be unconcerned about the condition of the coatings of the hold surfaces, provided that those surfaces are clean and free from loose rust, but for some cargoes rust can be a problem. One such cargo is salt used for the preserving of fish; rust on the surfaces in the hold will discolour the salt with which it comes into contact. If this is a possibility it will be necessary to limewash the hold-to coat the bulkheads and the tanktop with lime-to prevent the salt from coming in contact with the rusty surfaces. Sulphur is another cargo for which the holds have to be limewashed.

Limewash is made by mixing one part by weight of slaked lime (hydrated calcium hydroxide-$CA(OH)_2$) with three parts fresh water. This job can be done in the hold, the product being mixed in a 200-litre drum. The limewash can be applied to the bulkheads with the hose of a portable sump pump, the pump being used to draw the wash out of the drum. It will be necessary to limewash the bulkheads to whatever height the cargo is expected to reach in the holds, but should not be necessary to limewash the deckhead. The aim must be to cover bulkheads and tanktop with a good, thick even coat of limewash. The limewash will dry in a few hours.

Painting of holds: Opportunity is sometimes taken, on ballast passages or during a period at anchor, to touch up hold paintwork or to repaint holds. When such work is considered it should be remembered that receivers and authorities in importing countries are becoming increasingly determined to ensure that foodstuffs are not contaminated with any harmful substance.

When foodstuffs are to be loaded and when a hold has been recently painted, the authorities in some countries insist on seeing evidence that the coating will not harm foodstuffs. The paint compliance certificate described and illustrated in Chapter 14 is an example of the sort of evidence that may be required.

If the ship possesses no certificate for the paint and there is doubt about the wisdom of painting, owners should be consulted. If they wish the ship to proceed with hold painting they can, if necessary, consult charterers and paint manufacturers.

Ballast holds

Ballast holds can be used either to hold ballast or to carry cargo. When cargo is to be carried it is essential that the proper steps are taken to ensure that ballast water cannot be admitted to the hold by accident.

This is usually achieved by bolting a watertight coverplate over the ballast suction in the hold and this may be reinforced in the engineroom by fitting a blank, padlocking a valve or posting a notice. Blanks or cover plates which were fitted to the bilge and CO_2 smothering lines must be removed, so that these systems can operate whilst cargo is being carried.

These processes may have to be done, hurriedly, in the loading port since the hold may have been used for ballast during the previous ballast voyage.

There is likely to be a conflict of interests between the requirements for cargo and ballast, particularly when low density cargoes are carried, filling all cargo spaces including the ballast hold. At such times it may be difficult to find time and opportunity to clean the ballast hold at the start of the ballast voyage, before the hold is ballasted. Where possible the hold should be washed or, failing that, swept. If a hold is ballasted without removal of sweepings as a result of pressure of time, problems with blocked suctions will almost certainly be met at the time of deballasting, when the hold may be urgently required for loading.

Before ballasting it is, of course, essential to remove any blanks or coverplates which have been fitted to ballast suctions within the hold and to seal the CO;. lines.The bilge suctions must also be sealed to prevent ballast from leaking through the bilge system. Aboard some ships, the same coverplate is used for the bilge and the ballast suctions and must be unshipped from one position and bolted in place in the alternative position.

Because of the time pressure which often exists when ballast holds have to be cleaned and ballasted, it is useful to consider the priorities:

- Before a ballast hold is ballasted the ballast line must be unsealed and the bilge line and CO_2 injection must be sealed.
- Any sweepings or rubbish which could block the ballast suction must be removed from the hold.
- If time permits and the next cargo will or may require a high standard of cleanliness, the hold should be meticulously cleaned.
- If there is insufficient time to clean the hold thoroughly or if the ballast water is dirty, there may be an opportunity to deballast the hold and clean it during the voyage, refilling with clean sea water thereafter if necessary.
- If there is no opportunity to clean the hold at sea and a clean hold is required quickly in the loading port, the crew can usually commence hosing down the open hold from deck level whilst the ballast is still discharging and can enter the hold to continue washing down when the water level reaches 30-40 cm over the tanktop.

When the ballast has been discharged and washing down, if required, has been completed, a fresh water rinse will be required for cargoes which require holds which are free of salt. On completion of washing and rinsing, the bilge suction and CO» injection must be opened and tested and the ballast suction must be blanked off. Sufficient time to complete these tasks must be provided in the loading plan.

Sources

93. Marpol 73/78. Consolidated Edition, 1991. IMO.

150. *Bulk Carriers: Guidance and Information to Shipowners and Operators.* International Association of Classification Societies. April 1992.

153. Baldwin, K, G. 'Hold Washing and Pollution'. *Seaways,* July 1992.

CHECKLIST–Items for attention when preparing holds for cargo

- ☐ Encourage stevedores to discharge cargo sweepings as far as possible.
- ☐ Have crew or stevedores sweep down deckheads and bulkheads as discharge proceeds–for example, with grain cargoes.
- ☐ If cargo has filled a bilge have crew clean it before completion of discharge, so contents can be discharged.
- ☐ Sweep holds before washing to remove bulky cargo residues, if required.
- ☐ Holds will not be washed if:
  - Same cargo is to be carried again and charterers want no cleaning.
  - Clean cargo like steel coils has been carried.
  - Freezing conditions do not permit washing.
  - Vessel will remain in areas where discharge of washings is not allowed.
- ☐ Decide if full wash or bottom wash is required, and if washing is to be done by automated washing or by handheld hose.
- ☐ Decide if washing is to be done at berth, within port limits or outside limits, taking account of any restrictions on discharge of cargo residues and anticipated weather and sea state.
- ☐ Obtain written permission from port authority to discharge hold washings if intend to wash in port.
- ☐ Wash holds:
  - Wash hatch covers, top, bottom and sides.
  - Scrub hatch cover compression bars & rubbers if necessary to remove cargo traces.
  - Wash hatch coamings.
  - Wash hold deckheads.
  - Wash hold sides, paying particular attention to hopper angles, pipe guards, brackets and other non-vertical surfaces.
  - Scrub locally and/or rewash to remove stubborn dirt.
  - Wash deck, scrape up loose rust scale.
  - Flush bilges.
- ☐ Rinse holds with fresh water when possible to reduce corrosion and to prepare for cargoes which cannot contact salt.
- ☐ Dry holds by ventilating, by opening holds and/or by mopping up puddles, as necessary.
- ☐ Sweep holds instead of washing when washing is not necessary.
- ☐ Scrape and sweep holds and lift residues from hold when washing is not possible.
- ☐ Clean and disinfect bilge wells.
- ☐ Flush sounding pipes and thermometer pipes.
- ☐ Test bilge suctions if not already used for washing.
- ☐ Test bilge non-return valves, when fitted.
- ☐ Test bilge high level alarms, when fitted.
- ☐ Inspect holds for cleanliness, insect infestation, leakage and damage. Remedy defects where necessary.
- ☐ Wrap bilge cover plates with burlap and seal with tape or cement.
- ☐ Reseal any manhole covers which have been opened or disturbed.
- ☐ Isolate hold lighting and lighting in compartments connected to the holds, when this precaution is required for intended cargo.
- ☐ Limewash bulkheads and tanktop if required for next cargo.
- ☐ If holds are painted, or touched up, before a cargo of foodstuffs is carried, ensure that a paint compliance certificate can be produced for the paint used.
- ☐ In ballast holds, close and secure cover plates for ballast suctions, and open bilge suctions and CO_2 injection lines.

CHAPTER 6

ENSURING SYSTEMS ARE OPERATIONAL

Ventilation, airpipes, hold bilges, soundings, hold temperature systems, deck and hold lighting, fire smothering systems, hatchcoaming drains, deck machinery, derricks and cranes

A BULK CARRIER exists to carry cargo, and is expected to do so safely, efficiently and without loss. To achieve this the ship's equipment must all be in good working order. This can only be achieved by regular maintenance, described in Chapter 23, and by methodical proving of all the systems every voyage. This chapter is devoted to the routines, tests and inspections which must be carried out regularly to ensure that everything is in good order before a cargo is loaded, and at other stages in the voyage.

In general, every item listed in this chapter should be inspected or tested before each cargo is loaded and the hatches are battened down. This is particularly true for larger bulk carriers completing only six or eight loaded voyages a year. Some items, it will be obvious, must also be dealt with before the commencement of each discharge. On mini-bulkers performing one or more voyages a week most items must still be checked each voyage, but some can be left for regular but less frequent inspection.

Hold ventilation

The hold ventilators must be in good working order to fulfil two functions. First, they must provide adequate ventilation to the hold if required. Second, they must be capable of being completely sealed to prevent the entry of water in adverse weather conditions, and the entry of air if a fire occurs which must be smothered.

The variety of designs of hold ventilators are described in Chapter 15. Vents which are closed by doors (Fig.6.1) should be checked to ensure that the rubber seals have not been covered with paint, become permanently indented or cracked and brittle with age.

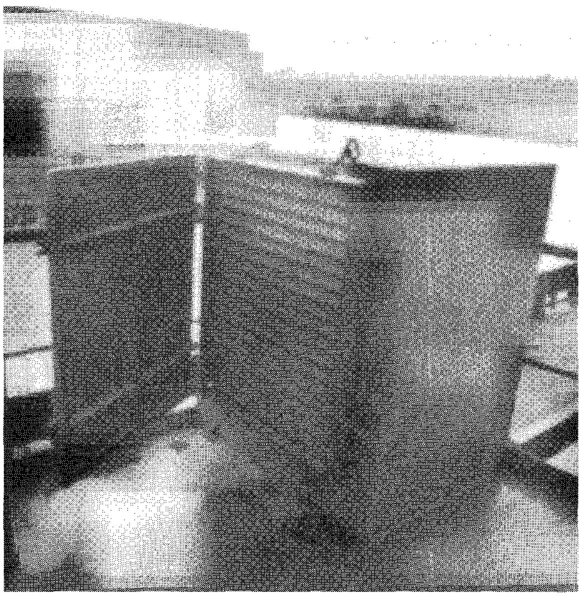


FIG. 6.1

Confirm also that the door closes properly, and that the sealing bar meets the centre of the door rubber. The hinges should be undamaged, and they and the butterfly nuts should move freely.

Located somewhere in the trunking of each ventilator, or at the point when it enters the hold, is a light metal grille which prevents sparks, insects and rats from entering. This can normally be reached by way of an inspection panel, set somewhere in the ventilator trunking. The grille must be renewed if it is damaged or wasted, and loose rubbish and scale must be removed from it.

Mushroom ventilators (Fig.6.2) are usually closed by turning the wheel which is set on top. This brings a damper plate inside the mushroom cowl into contact with the lip of the vent trunking. A 'rubber' (neoprene) seal is set into the damper plate, and it must be in good condition to ensure a watertight fit. The seal can be inspected when the vent is open by looking upwards into the vent cowl from a position on deck beside the ventilator. The grille in a mushroom ventilator is usually fitted in several parts, located in the position illustrated, and must be renewed if damaged.

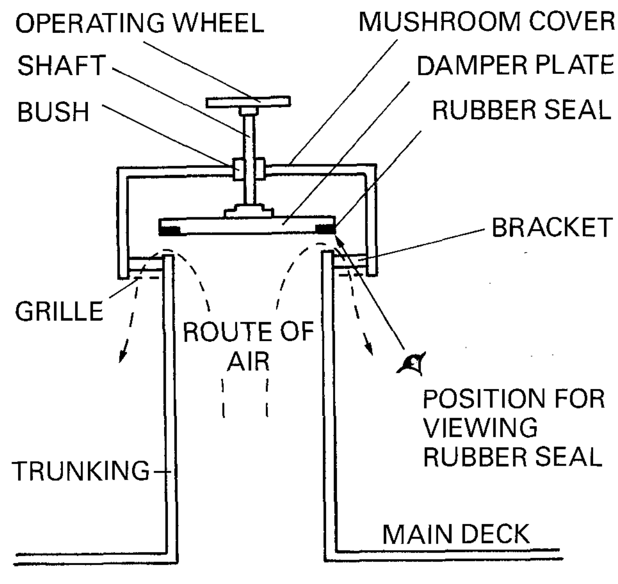


FIG. 6.2

The shaft of the wheel must be greased and working freely. If the shaft is coated with grease and the grease has become contaminated with dust and grit from the cargo the shaft is likely to jam. Before the vent is opened, the contaminated grease should be removed from the shaft. Then the threaded part should be wiped with a rag soaked in paraffin before the ventilator is opened and closed, and the shaft is regreased. The wheel must be clearly marked with the 'Open' and the 'Close' directions, and the marks should be checked to be sure that they have not been reversed-mistakes can easily occur on older ships when the original plates have wasted, and been replaced by painted signs.

Ventilators which end in mushroom cowls at the heads of samson posts (Fig.6.3) are provided with ventilator flaps set in the trunking. When the lever is operated these flaps should move freely between the 'Open' and the 'Closed' positions, which must be clearly marked. The flaps should be inspected to confirm that the open and closed positions are correctly marked, and to ensure that the ventilator flap does turn with the shaft to which it is supposed to be attached. On some ships the flap is fastened to the shaft with bolted collars. Wastage can allow the fastenings to become loose. Such ventilator flaps are not always easily accessible but they and the grille can usually be inspected by torch from an access panel somewhere in the ventilator trunk.

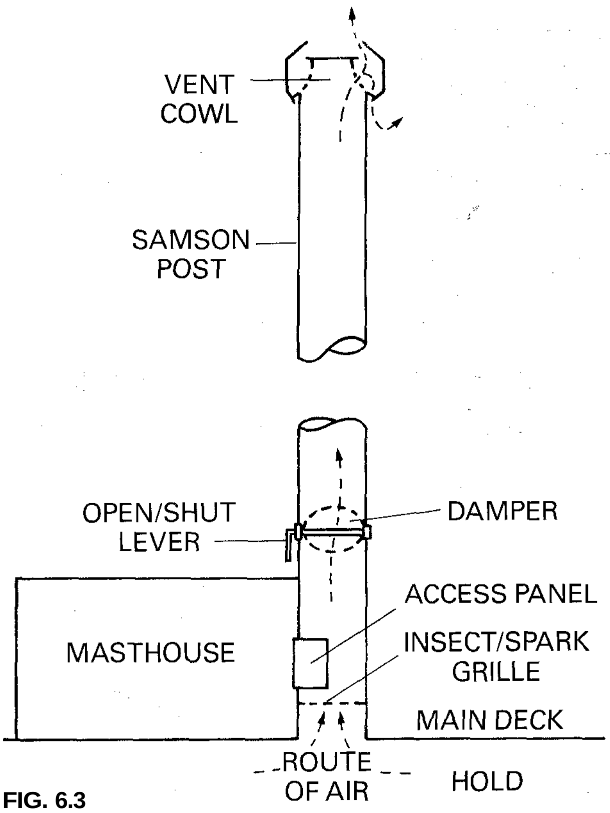


FIG. 6.3

All ventilators should be correctly labelled to show the compartment which they serve. Ventilators set into the hatch coamings usually consist of rectangular openings closed by steel doors with neoprene seals. The seals must be in good condition, the hinges and butterfly nuts must be free and greased, and the grille must be intact.

Some vessels are provided with portable mushroom ventilators for bolting to the hatch covers when ventilation of the hatch square is required, as may be the case when coal or grain cargoes are carried. Before the start of a voyage for which they are required such ventilators should be unshipped from their stowage positions, cleaned and freed as necessary to ensure that they are in good operating condition, and ready for fitting immediately when required. The bolted plates set into the hatch covers must also be freed, ready to receive the cowls.

If fixed fans are provided in the ventilator trunks for mechanical ventilation of the holds they should be tested whilst the holds are empty. First, they should be checked electrically to confirm that they are in good condition, and inspected by eye to ensure that nothing is lying on the fan blades. When ready to run all the options should be tested, including running fans in both directions where that is possible, and running them at full and at half speed. The fan trips and/or emergency stops should also be tested regularly.

On ships employed in areas where bad weather is common, such as north-west Europe, ventilators are normally kept permanently closed and sealed to prevent the entry of water. Despite this, it is still essential that all the working parts should be kept in good operating condition by following the procedures described above. It is only in this way that ventilators which work correctly can be guaranteed for the occasional voyage where ventilation is essential.

Ventilator trunks are liable to heavy corrosion in some trades, and sheets of loose scale can develop within them. From time to time the opportunity should be taken to remove scale from the trunks.

Tank airpipes

The airpipes (goosenecks) for ballast, fuel and fresh-water tanks must be kept in good order so that tanks can be filled and emptied without problem, and the entry of sea water can be prevented. Airpipes must be correctly labelled to show the tank that they serve. Their non-return system, allowing liquids out of the airpipe but not in, must be working properly. When the system uses a float (Fig.6.4) it must be visually inspected for damage, and to ensure that it seals the airpipe properly. Damaged floats must be renewed, and on older ships it is prudent to carry a few spares.

Hold bilges

The hold bilge wells must be thoroughly cleaned after every cargo, and all cargo sweepings must be removed. The bilge sounding pipes can be proved free by running water down them into the bilge, and the bilge suctions can be tested by pumping the bilge well dry.

The end of the bilge suction line is normally provided with a strum box, or grille, which prevents rubbish from entering the line. This must be clean. The non-return valve, fitted in the bilge line to ensure that water cannot enter the hold through the bilge line, must be tested. The easiest way to test the non-return valve is to stop the pump and allow water to flood back into the bilge line. If it flows through into the hold bilge the non-return valve, normally situated in the stool space or the duct keel, must be opened up and cleaned. In any event all the non-return valves should be cleaned at regular intervals.

On completion of inspections the bilge wells must be correctly closed, and their grilles must be covered with burlap. High level bilge alarms, when fitted, should be tested by raising the float towards the top of the bilge and confirming that the alarm sounds on the bridge and/or in the engineroom. (These matters are described more fully in Chapter 5.)

Soundings

The most reliable soundings of tanks and bilges are obtained with sounding rod and line, or sounding

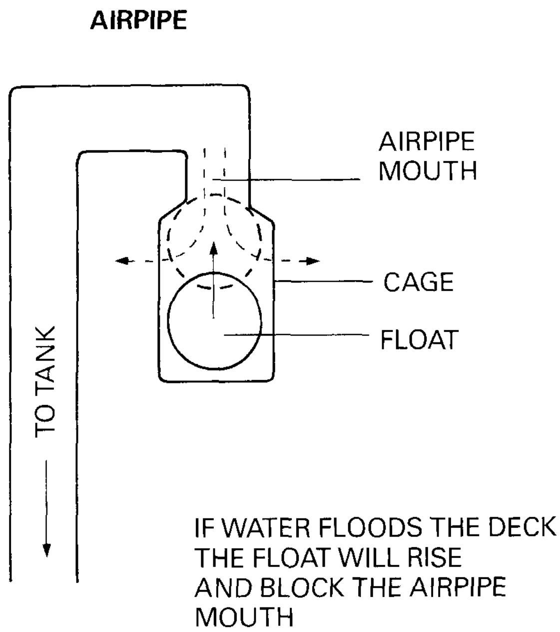


FIG 6.4

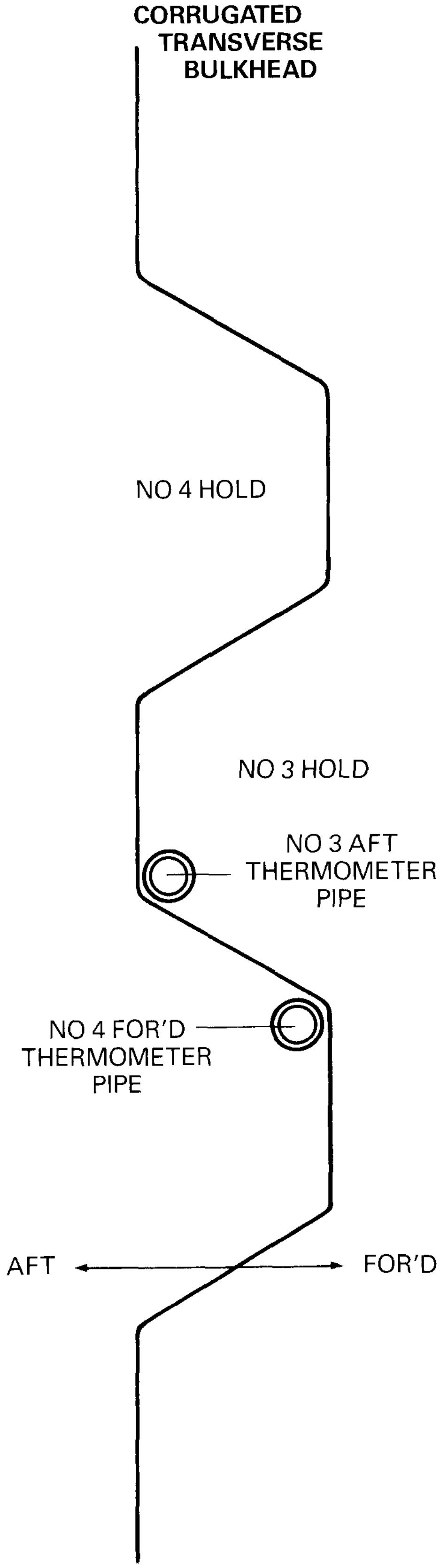


FIG 6.5

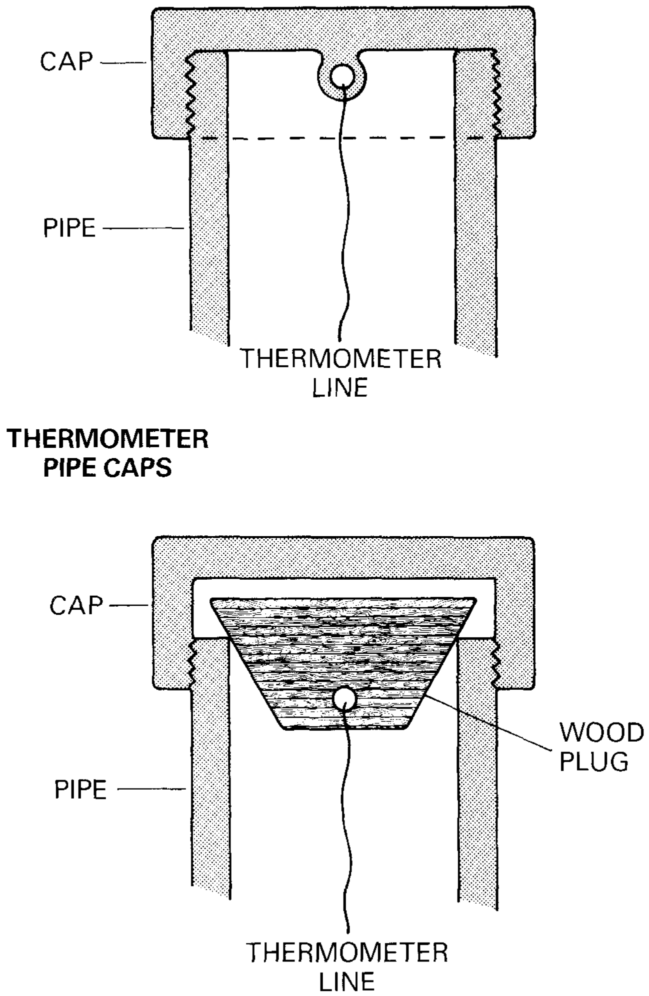


FIG 6.6

tape, in the sounding pipe, provided that the sounding pipe is clear. A sounding pipe can become blocked with cargo residues which can float into a hold bilge sounding pipe when there is water in the bilge, or with cargo or rubbish which can fall into it if the sounding pipe cap is left off. Loose rust and parts of old sounding rods and lines can also block sounding pipes.

As noted above, sounding pipes can be proved clear by running water down them into the bilge or the ballast tank. They can also be checked by viewing, from a position at the base of the sounding pipe, the arrival of the sounding rod in the bilge well or in the ballast tank. A table of tank and bilge ullages (i.e. distance from striking plate to top of sounding pipe), prepared from careful direct measurements and checked against the ship's plans, can also be used to check if sounding pipes are clear.

Another quick and simple check is to compare the ullages found for similar soundings. The sounding rod should reach the same depth on the port side as on the starboard side. Similarly, aboard a large bulker the Xo.3 bilge or double-bottom tank sounding will, for example, probably be the same depth as the equivalent No. 4 soundings. If the depths are found to be different, it is likely that a false sounding is being obtained in the pipe which appears to be shorter, and the cause of this must be investigated and removed.

A blocked sounding pipe must be cleared as soon as possible, and various ingenious methods can be used to remove the obstruction and return the pipe to its former sound condition. Every sounding pipe should be provided with a cap which fits well, opens and closely freely, and has a watertight rubber seal in place. To prevent water or rubbish from entering the pipe the cap should be fitted at all times except when the sounding pipe is being used.

The accuracy of remote reading systems for ballast tank soundings should be checked by comparison with actual soundings obtained with sounding rod. Before each cargo is loaded a remote reading system for soundings, when fitted, should be given routine maintenance in accordance with the manufacturer's handbook. The air pressure used by the system should be set to the correct value, according to the manufacturer's handbook. All empty compartments, including void spaces, bilges and dry tanks should be sounded and/or inspected to confirm that they are empty.

Hofd temperature *systems*

Cargo temperatures may be taken from sounding pipes, but are often read from separate pipes, similar to sounding pipes, positioned at the forward and after ends of each hold. Ensure that temperature pipes are correctly labelled. Their positions against the corrugated transverse bulkhead can mean that No.4 for'd is forward of No.S aft, for example (Fig.6.5). The caps of temperature pipes must fit well, have watertight seals and be kept in position except when the pipe is in use. The base of the pipe must be checked to ensure that it is free of water, and that the opening in the base is clear, and guarded with light metal gauze or a similar product. Water standing in the pipe would produce water vapour, and might depress the temperature readings. Any damage to the pipes, sustained when discharging previous cargoes, should have been found and repaired.

Thermometers should be inspected for any apparent faults, such as breaks in the mercury or alcohol, and compared with other thermometers in use around the ship-for example, in the refrigerators, storerooms, engineroom and on the bridge-to confirm that their readings agree.

The lines used to lower the thermometers into the pipes should be in good condition, and of the correct length to reach the depth required. If possible the thermometers should be left permanently hung in the temperature pipes, so that a set of temperatures can be taken quickly when required. The line can be fastened to the underside of the pipe cap, or attached to a plug placed in the top of the sounding pipe, provided that a watertight seal can be maintained (Fig. 6.6).

Lighting

All deck and hold lighting should be switched on for inspection before the loading port is reached, and bulbs and tubes should be replaced as required. If the cargo is hazardous the hold and hold access lighting must be isolated before the commencement of loading, and the circuit fuses should be removed to a safe place in the care of a responsible officer.

All lights should be maintained on a regular basis, such maintenance to include the greasing of moving parts, freeing of securing dogs, checking and renewal of glass covers and rubber seals as required, and inspection of wiring and conduits. Cable conduits in the holds should have already been checked for physical damage which may have occurred during the last discharge. Following rough weather, cable conduits on deck, if damaged, may contain water which should be drained.

Portable deck and hold lighting is required in any port where the shore lighting is inadequate, and also for security purposes. A ship committed to worldwide trading should hold a minimum of four portable floodlights or 'clusters' for each hold, two to light the hold and two to shine over the ship's side to illuminate the jetty or craft alongside. Ships engaged in regular trading between well equipped ports are unlikely to need so many portable lights, but should carry extra lights for security and anti-piracy purposes.

Before reaching each port the portable lights should be tested, bulbs should be replaced and repairs should be made as necessary. The cables should be inspected for damage. Rope lanyards should be long enough to hang the lights in the correct position. A portable light should never be hung by its electrical cable. Light bulbs must always be protected by a wire cage or screen.

Fire *smothering systems*

The basic components of the fire smothering system are the battery of gas bottles in the bottle room, the mechanical control system for selecting the compartment to be smothered and for controlling the number of bottles released, the gas pipes which carry the gas to the compartment, and the nozzles which emit the gas. On modern ships the nozzles, four in number, are usually set in the hatch coamings, so that no pipework is within the holds. On older ships the gas pipes often enter the hold and lead to nozzles located under the dcckhead (Fig.6.7).

If a smoke detecting system is also provided, as is often the case on handy-size and smaller bulkers, a fan will be used to draw air samples continuously from each compartment through the gas lines to a detecting cabinet, usually placed on the bridge, where a photoelectric cell will detect smoke and cause an alarm to sound.

Problems and their prevention: A number of problems can and do occur with these systems. The pipes which carry the CO_2 from the bottle room to the hold, the gas lines, can fill with water from condensation, or can be blocked by cargo residues when cargo such as grain is loaded up to coaming level. In the case of the ballast hold the lines can also be flooded with ballast water, while the gas lines within the holds of older ships can be damaged by cargo operations.

When the lines are blocked with water or residues, the smoke detecting system cannot work, and the CO_2 smothering may be ineffective. To prevent or correct some of these problems the manufacturers may include a variety of fittings in the system:

- Each gas line may be fitted with an individual drain valve for the removal of water.
- Each CO_2 nozzle may be provided with a spring-loaded shutter which must be shut by hand when grain or similar cargo is carried, and opened after the cargo has been discharged.
- Each CO_2 nozzle may be provided with a removable dust cap which will be blown off if the CO_2 is released.
- Each gas line serving a ballast hold may be provided with an isolating valve, to be closed when ballast is carried and opened when cargo is carried.
- Each gas line serving a ballast hold may have a 'spade', or 'spectacle', piece (i.e., a blank) which can be used to seal the line in the same way that an isolating valve does.
- Each gas line serving a ballast hold may be provided with a non-return valve which will admit CO_2 gas to the hold, but will exclude ballast water from the gas lines.
- 'U' bends, placed in the gas lines at positions higher than the coaming top, may be used to prevent ballast water from entering the lines.

Shutters when fitted are spring loaded, and will be forced open by a gas pressure of more than $1.5 kg/cm^2$. If the gas lines can be shut by a valve, there is often a bypass line fitted with a pressure disc, for each valve. The pressure disc will burst to admit the CO_2 gas into the hold in the event that smothering is required when the valve has been left shut, by mistake. Unfortunately, the pressure created by ballast water, pressed up or sloshing in the ballast hold, can also burst the disc and allow ballast water into the gas lines.

From the foregoing it will be clear that the CO_2 system must be properly understood, and correctly set for ballast or cargo. At the ballast hold the gas lines must be closed when the hold is ballasted and open when cargo is carried. At all holds it may be necessary to close the shutters or fit the dust caps over the nozzles to keep out dust or light cargo, and to open the shutters for other cargoes.

Routine testing-the gas lines: These problems, and the varied methods provided for their solution, make it easy for the gas lines to be blocked by waste matter, or by a shutter, valve or blank wrongly set. The most important rule, therefore, is to make absolutely sure before each cargo is loaded that the gas lines are not blocked or closed. This should be done by blowing through each line in turn with compressed air.

Most systems have a compressed air connection in, or near to, the CO_2 bottle room, so that compressed air can be blown into each compartment by operation of the appropriate valves. Often there are two blanks to be changed before the compressed air test is made:

SCHEMATIC DIAGRAM OF
CO_2 SMOTHERING & SMOKE DETECTING SYSTEM

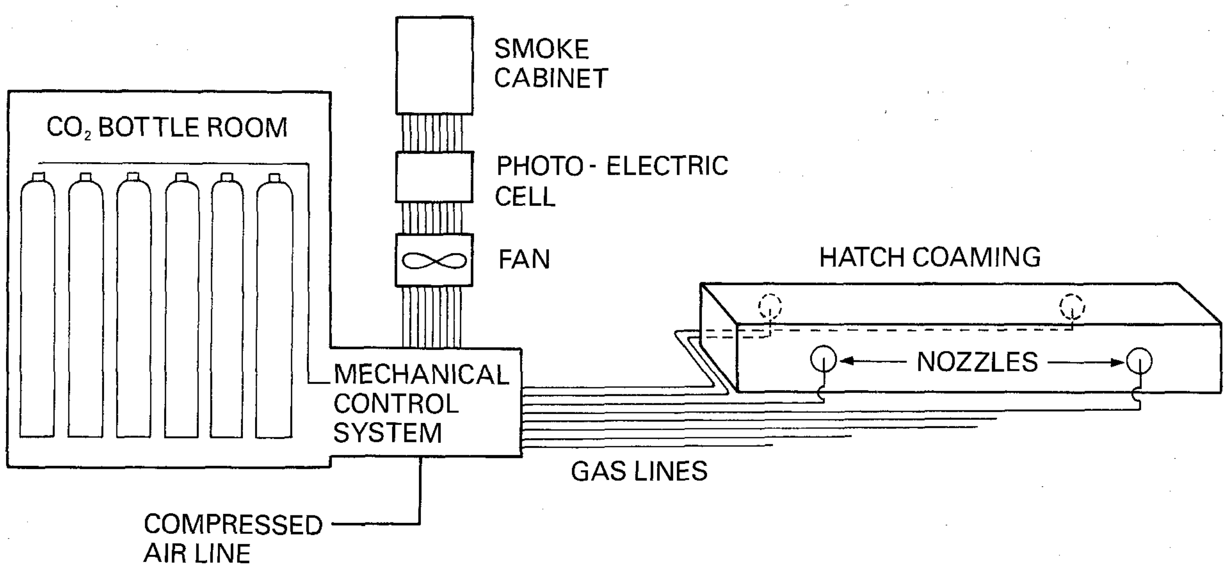


FIG 6.7

one blank is removed to admit compressed air into the system, whilst a second blank is fitted to protect the CO_2 bottle bank lines and trips, and the smoke detecting cabinet, if fitted. An observer should listen at the hold for the sound of the escaping compressed air, which will show that the outlet is clear. When the test is completed the blanks must be refitted in their original positions.

Oxygen must not be used to blow through the gas lines, as it can cause an explosion if it meets a trace of oil. Water should not normally be used to blow through the lines, since the object is to keep the lines free of water. If salt water ballast has entered the lines, however, they should be flushed with fresh water to remove the salt which will cause corrosion, and then blown through with compressed air to dry them.

Routine testing-the smoke detecting system: The smoke detecting system, when fitted, must be tested in each hold at the start of each voyage with a smoke-making device. Smoke can be produced from an oily rag in a can, from a chemical device such as a draeger tube, or from a smoke aerosol. Provided that the photoelectric cell and the fan which draws air into the cabinet are both switched ON, and provided that the gas lines are not blocked, the release of smoke close to a nozzle in the hold will cause the smoke alarm to sound at the smoke detecting cabinet.

Routine testing-for safety equipment certificate: In addition to the above-mentioned checks, to be carried out every voyage, the smothering system should be maintained in accordance with the manufacturers' advice, and the gas bottles should be inspected, have their contents checked, be pressure tested and recharged as required by the authority issuing the Safety Equipment Certificate.

Hatch coaming drains

If the hatch coaming drains are blocked with cargo, as happens easily and frequently, the danger of leakage of water into the holds is increased. It is essential to ensure that the drains are checked and cleared, and that their non-return valves (Fig.4.10)-often containing a floating ball-are free before the loading of each cargo, and again after loading, and before battening down the hatches. Compressed air directed upwards from the bottom of the drain is a quick and effective method of clearing a blocked drain. If this doesn't work, the non-return valves must be dismantled and cleaned, and any blocked drain pipe must be cleared with a stiff rod, or even by the use of a drill if badly blocked.

On long voyages, and in cold weather, the rubber ball of the non-return valve may stick. A quick poke with a rod or screwdriver will free it.

Deck machinery

Deck machinery on a bulk carrier includes the windlass, mooring winches, capstans and hatch-opening motors. It also includes air motors used on deck, and cargo-handling gear, such as cranes or derricks and their winches, if fitted.

Before arrival in port, deck machinery should be tested in good time to ensure that it is operational. An exception must be made, of course, in cases where the vessel enters port directly from a bad-weather passage. In these circumstances the best that can be done is to inspect and test deck machinery as soon as possible after reaching sheltered waters.

Windlasses and winches on bulk carriers are usually electro-hydraulic, or occasionally electric. Problems are most likely to occur if they are not properly lubricated, and if the electric controls become wet. The grease nipples at each bearing must be regularly greased. The level of lubricating oil in the sumps of winches should be checked, which is usually done by looking through the glass viewing port, and they should be topped up as necessary. The lubricating oil will turn milky if water has been forced in and mixed with the oil. If that happens the seals must be renewed and the oil must be changed, which is a major task.

Motors in exposed positions, control pedestals for deck machinery, and emergency stop buttons can usefully be provided with canvas or waterproof covers to protect them from heavy spray or rain, and these should normally be fitted at sea. They can be temporarily removed in hot dry weather to give covers and equipment an airing. Heaters for deck machinery, when provided, should remain switched on at sea to provide a warm dry atmosphere for the electric control systems.

The hydraulic systems for operating the hatch covers and the deck machinery depend upon an adequate supply of hydraulic oil. The levels in the header tanks should be checked before entering port, and the tanks should be topped up as necessary from the storage tank in the motor room.

When the deck machinery and services are switched on, the decks should be checked for hydraulic and pneumatic leaks, which sometimes develop as a result of the ship working in a seaway or vibration during the passage. Any leaks which are found should be promptly repaired, and any leakage of oil cleaned up.

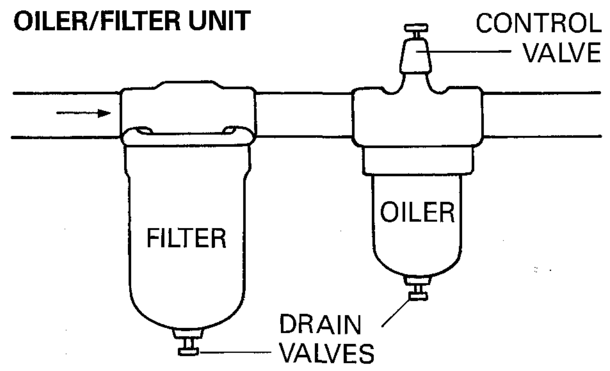


FIG 6.8

Air motors are likely to be used for accommodation ladders, for pilot hoists, for stores and bunker davits and for lifeboat hoists. It is prudent to confirm that they are all in good working order before arriving in port. The oiler/filter unit (Fig.6.8) with which each air motor is provided cleans and lubricates the air before it enters the motor. The air is cleaned and dried as it passes through the filter: the filter must be cleaned or renewed as required. The oiler unit adds oil to the air, thus ensuring that the motor receives the necessary lubrication. The level of oil in the oiler must be maintained, and the oil must be changed if it becomes milky due to water contamination.

A control valve on the oiler governs the amount of oil which is added to the air. The valve should be opened wider when the surroundings are dust laden, or if the motor is seldom used, though some operators play safe and always leave the control valve fully open.

The vanes of air motors can become chipped or corroded, and spare vanes should be carried. If the motor seems to have reduced power-for example, if it cannot lift the accommodation ladder-it should be dismantled and cleaned. The condition of the vanes should be checked and damaged vanes should be renewed. Vanes sometimes stick if the motor is not used for a long time-in these circumstances a sharp tap on the casing often frees them. Do not tap too hard, however, as the casings are often cast, and will fracture if struck too hard!

Cargo-handling gear

Geared bulk carriers are distinguished from gearless vessels by the fact that the former are equipped with derricks or cranes, which can be used to load or discharge cargo. It is quite common for handy-sized and mini-bulkers to be geared, but unusual for larger vessels to be so equipped. Geared vessels often visit well-equipped ports where the loading or discharge is carried out with shore equipment, which can handle cargo faster and with more flexibility, but such vessels really show their worth when required to serve poorly equipped ports and anchorages which have no shore-based gear.

Unexpected circumstances, such as a change of discharging berth, a failure of shoreside equipment or a strike, can result in the ship being instructed at short notice to work cargo with the ship's gear. Failure of even one derrick or crane will usually break the terms of the ship's charterparty, and result in loss of hire payments.

Cargo-handling equipment which fails when in use can cause death, serious injury or extensive damage as a result of a falling weight. As a consequence most flag States and most port States have strict rules about the design, construction, testing, certification, marking, maintenance and inspection of cargo-handling equipment. Some countries are well known for their insistence that the ships which visit their ports comply scrupulously with the regulations, and in most countries a ship which was in breach of the regulations when an accident occurred would be held liable.

When entering any port, the shipmaster should ensure that all the cargo-handling equipment is in good working order, and that it complies with the regulations of the ship's own flag State and also, if possible, of the port State. Much of this can be achieved by ensuring that the equipment is given the necessary regular maintenance, a subject discussed in Chapter 23. Regular maintenance is essential for keeping the cargo gear in good condition, but will not in itself guarantee that all will work well during a port visit. Deterioration of cargo gear is governed by how much it is used (too much use and too little are both bad for it), the extent to which it is mistreated, and the adverse weather met by the ship. There are a number of matters which must receive attention before the ship reaches port, and thereafter whilst cargo is being worked.

Maintenance of the cargo gear must be up to date, and every item of cargo gear must be permanently marked with a unique set of numbers and/or letters. A proper certificate must be held for every item of cargo gear, and must be readily available for inspection. Every item of gear must be clearly marked with its safe working load (SWL). All moving parts of the system must be working freely, and sufficiently greased or oiled. They may require oiling and greasing again after a rough weather sea passage, paticularly if the vessel was deep laden. All shackles above eye level must be moused (fastened with lashings of seizing wire), or with split pins, to ensure that they cannot become accidentally unfastened. The gear must not include any damaged items of equipment. In addition, the following specific items should be checked.

The condition of wire ropes should be checked before commencement of cargo work, and those which are flattened, kinked, reduced in diameter, damaged or showing more than 5 per cent of broken, worn or corroded wires in any length of ten rope diameters should be renewed. Inspections of the wire ropes used in cargo gear should continue each day whilst cargo is being work. The anchorages used to fasten the ends of wire ropes to winch drums should be regularly checked to ensure that they are tight.

Derrick winches and crane machinery must be kept in good condition, following the same guidelines as already described for deck machinery. They must be greased, lubricating oil in sumps must be topped up as necessary and signs of contamination by water must be sought. Electric control pedestals and switch gear must be kept warm and dry.

When gear has been dismantled for maintenance it must be carefully inspected and carefully used after reassembly. It has been known for the more complex derrick rigs to be wrongly rerigged after the renewal of topping lift wires, with insufficient wire on one topping lift winch drum and too much on the other when the derrick was amidships, or with topping lift wires which failed to pass through a full set of topping lift sheaves/ Some such problems can sometimes be avoided by attaching the new wire to the old wire with seizing wire or a patent cable stocking and hauling the new wire into position whilst removing the old wire.

Most derrick and crane systems are provided with limit switches, to prevent the derrick or crane from luffing too high or too low, from slewing too far to either side, or from hoisting too high or lowering too far with a load attached. These limit settings must be checked, tested and reset frequently to ensure that they continue to keep the movements of the derrick or crane within the limits for which it has been designed. Override keys are provided so that the derrick boom or crane jib can be lowered into the stowage position, or topped clear of the hatch when carrying no load. The override keys must be held by a responsible member of the ship's company, to ensure that shore drivers do not override the limits recklessly.

An emergency cutout may be provided so that an operation can be stopped instantly, by pressing a button and tripping the electrical supply. The emergency cutout can be used by the officer of the watch to immobilise the crane at the end of the working day, to prevent unauthorised use. To restart the crane the trip switch, usually placed in a locked cabinet, must be reset. The cutout should also be used when maintenance work such as overhaul of the electrics or greasing of the topping sheaves is being carried out. Cutouts should be tested frequently; their use for immobilising the crane is one method of doing this.

Some cranes and derricks are provided with overload cutouts. These cause the power supply to cut out if the load exceeds the value set, normally the safe working load. An overload cutout can prevent overloading when ship's gear is being used with shore grabs, or if lifting containers or logs where the weight may be unknown or wrongly declared. An overload cutout may also be designed to cut out the power supply if a motor becomes overheated because of lack of lubrication or because the ventilator is not open.

The brakes for crane and derrick winches are automatically applied by heavy springs whenever the winches are not being driven. They must be checked regularly. A quick indication of their effectiveness can be obtained by suspending a heavy load a short distance above the deck or quay. Any lowering will show that the brake is ineffective.

Other systems which must be operational

The maintenance and testing of hatch covers are described in Chapter 4. The preparation of the holds for cargo is described in Chapter 5.

CHECKLIST – Items for attention before arrival at the loading port.

(The routine at the discharging port for lighting, deck machinery and cargo gear should be the same as is stated hereunder for the loading port.)

Any item tested or inspected, and found defective, must be put in good working order.

Holds and hatch covers

- ☐ Maintain hatch covers as described in Chapter 4.
- ☐ Test hatch covers as described in Chapter 4.
- ☐ Prepare holds as described in Chapter 5.

Ventilators for holds and hatch coamings

- ☐ Means of closing to be in good working order.
- ☐ Seals on closing plates to be in good condition.
- ☐ Grilles to be unbroken.
- ☐ All moving parts (hinges, spindles, flaps) to be well greased and working freely.
- ☐ Means of closing to be correctly marked Open/Closed.
- ☐ Ventilators to be correctly labelled for hold served.
- ☐ Prepare portable ventilators if required.
- ☐ Test ventilator fans.

Airpipes (goosenecks)

- ☐ Inspect airpipe non-return valves.
- ☐ Confirm airpipes are correctly labelled for tank served.
- ☐ Ensure that fire gauzes for fuel tank airpipes are intact.

Hold bilges

- ☐ Bilge wells to be clean and dry.
- ☐ Strum boxes to be clean.
- ☐ Test bilge suctions.
- ☐ Test bilge suction non-return valves.
- ☐ Test bilge high level alarms.
- ☐ Fit bilge well covers and cover them with burlap.

Soundings

- ☐ Prove sounding pipes clear.
- ☐ Provide sounding pipes with well fitting watertight caps.
- ☐ Confirm the accuracy of any remote sounding system.
- ☐ Sound or inspect all empty compartments, including void spaces, to prove them empty.

Hold temperature system

- ☐ Pipes to be undamaged and proved clear, and free of water.
- ☐ Pipes to be provided with watertight caps which fit well.
- ☐ Thermometers to be sound and accurate, and provided with lines which are in good condition, and of correct length.

Lighting

- ☐ Test deck, access, hold and portable lighting.
- ☐ Inspect cable conduits for water and damage.
- ☐ Isolate hold lighting and hold access lighting before a hazardous cargo is loaded. Keep fuses in a secure place.
- ☐ Have sufficient portable lights ready.
- ☐ Inspect the cables of portable lights.
- ☐ Fit lanyards to portable lights, and do not hang lights from their cables.

Fire smothering systems

- ☐ Blow through the gas lines with compressed air.
- ☐ Inspect the gas lines in the hold for damage.
- ☐ Test the hold smoke detector system, if provided.
- ☐ Shut off the CO_2 nozzles with shutters, where provided, when carrying cargoes such as grain or sugar.
- ☐ At each ballast hold: close the gas lines with blanks or valves when ballast is to be carried, and open them when the ballast hold is to contain cargo.
- ☐ Inspect pressure discs, if fitted, and renew any which have burst.

Hatch coaming drains

- ☐ Hatch coaming drains to be clear.
- ☐ Non-return valves in drains to be free.

Deck machinery, including crane and derrick winches

- ☐ Test all machinery before arrival in port.
- ☐ Keep machinery greased and oil topped-up in sumps.
- ☐ Watch for water leakage into sumps.
- ☐ Keep electric controls and switch gear warm and dry. Remove canvas covers in warm, sunny weather.
- ☐ Keep hydraulic oil header tanks topped up.
- ☐ Inspect for hydraulic and pneumatic leaks.
- ☐ Clean or renew filters, and top-up or change oil as necessary, in the oiler/filter units of air motors.

Cargo-handling gear

- ☐ Maintain cargo gear in compliance with the rules of the vessel's flag State.
- ☐ Every item of equipment to be stamped with an unique identifying mark, for which there must be a certificate which can be produced immediately.
- ☐ All gear to be clearly marked with its safe working load.
- ☐ All moving parts to be well greased or oiled.
- ☐ All shackles above eye level to be moused.
- ☐ No damaged items of gear to be used.
- ☐ Inspect wire ropes and their anchorages.
- ☐ Inspect gear carefully for rigging errors if it has been unrigged.
- ☐ Test limit switches frequently and reset them when necessary. Put override keys into safe keeping.
- ☐ Test emergency cutouts.
- ☐ Test overload cutouts.
- ☐ Test brakes.

Chapter 7

BALLAST MANAGEMENT

Basic pattern of ballast management, relevant regulations, ship's ballast layout, quantity of ballast required, ballasting whilst discharging, ballast management on passage, restrictions on deballasting, deballasting, achieving good results, maintenance of ballast tanks, removal of sediment and scale, patching of leaks, maintenance of coatings in tanks, inspections, closing of tanks

ABOARD BULK CARRIERS sea water is used as ballast to improve the ship's draft, airdraft, stability, trim and list. In terms of convenience and cost it is a great improvement upon the shingle which used to serve as ballast in nineteenth century sailing ships, but it brings its own problems, such as the damage which water can cause if it leaks into the wrong compartment, sloshes in a part filled tank, or contaminates the water into which it is discharged.

The basic pattern of ballast management is familiar to most seafarers, as cargo is discharged ballast is loaded to maintain the vessel at an acceptable draft and trim. The voyage from discharging port to next loading port is then undertaken in ballast. It may be a requirement of the destination country that ballast is changed in the open ocean, to prevent the discharge of ballast water from the port area of one country into the waters of another country with different forms of marine life.

Ballast is discharged in the loading port before and whilst loading takes place. At other times small quantities of ballast may be loaded or discharged to achieve the required trim or list, and ballast may be taken to preserve positive stability.

Since most raw materials are exported from areas requiring little return cargo, larger bulk carriers spend 40-50 per cent of their time in ballast whilst the smaller vessels able to load a wider variety of cargoes are on average in ballast for 30-40 per cent of the time.[28]

Ballasting procedures which protect the ship from heavy weather damage, avoid infringing regulations, and use minimum power for ballast pumping and for propulsion are an important element in the competitive efficiency of the ship's operation.

Regulations governing ballast management

Before considering the ballasting processes in detail it is worth recalling the restrictions which are placed upon ballasting operations.

- The appropriate 'in port' and 'at sea' limits for shear forces, bending moments and cargo torque, as specified by the classification society and stated in the Loading Guidance and Stability Information Manual, must never be exceeded. To ensure that they are not exceeded the values must be calculated and taken into account when ballasting is planned.
- Vessels which have the option of ballasting to a light ballast draft or a heavy ballast draft must ballast to the heavy ballast draft in adverse weather.
- A minimum forward draft for the vessel when at sea may be specified by the classification society. This figure will probably be 0.025L. (In a bulk carrier with L = 200m the minimum permissible forward draft would be 5 metres.)
- Adequate positive stability must be preserved throughout the voyage.
- Ballast tanks must not be overpressurised. The ballasting pressure will be too high and damage will occur if tanks are filled faster than the water can overflow from the airpipes when the tank is full. Such damage can occur if two pumps are used to fill a single ballast tank or if ballast tank airpipes are damaged or blocked.
- Ballast tanks must not be underpressurised. If tanks or ballast holds are emptied with airpipes and ventilators closed the resulting vacuum can cause severe damage to the deck structure, and hatch covers in the case of ballast holds.
- Regulations and/or recommendations govern the discharge of ballast water into the North American Great Lakes, and into the coastal waters of Australia and New Zealand.

Ship's ballast layout

Ballast pipelines: Each ballast tank is connected to the engineroom by a ballast pipeline running from tank to engineroom, through which the ballast water passes as the tank is filled or emptied. Each tank may have its own separate line, or all starboard tanks may be connected to one common ballast main and all port tanks to another. If there is a duct keel the ballast lines will run along it. Certain bulk carriers and OBOs are provided with ballast ducts formed by the double-bottom structure, instead of ballast pipelines. Such ducts are approved as suitable for use with a stated static head of water which must not be exceeded in service.

In the ballast tank the line ends in a 'bell mouth', an enlargement of the line which terminates in the lowest part of the tank about 3cm above the tank base. In the engineroom the line can be connected to a sea inlet by a choice of pipeline systems served by one or two ballast pumps, and a general service pump, so that the most suitable pumping option can be selected. (Fig. 3.4) In most cases, particularly in larger vessels, the line is also connected in the engineroom to an eductor or stripping pump for final stripping of the tank.

A plan of the ballast pipeline system of the *Regina Oldendorffis* at Fig. 3.3. This shows that each topside tank (TST), double-bottom ballast tank (WST—water side tank), peak tank (FPT), fuel oil tank (FOT) and hold bilge well (rose box) has its own separate suction/filling line. The plan also shows that the ballast suctions are positioned in the deepest parts of the tanks—inboard in the double-bottom tanks, and outboard in the topside tanks—at their after ends. This ensures the most efficient draining of the tanks, provided that the ship is upright and trimmed by the stern.

Duct keel: In smaller ships the ballast pipelines to the forward tanks pass through the after tanks to reach the forward ones. In larger Panamax and Cape-sized vessels a duct keel—a tunnel running fore and aft to contain ballast and other pipelines—is likely to be installed below the holds on the ship's centreline. This provides space for all pipelines and for most of the valves serving the holds and forecastle, and allows access to them for repairs and maintenance.

Airpipes: Each tank is also provided with at least one airpipe, and usually two—one forward and one aft—to allow air to escape as the tank fills, regardless of the ship's trim. The airpipes extend to sheltered positions on the upper deck. They come in a variety of designs which allow the passage of air, and the overflow of water, but which will not permit water to enter (Fig. 6.4). It is essential that this non-return arrangement (often a float) is well maintained and adjusted, if necessary, to ensure that accidental flooding of ballast or fuel tanks cannot take place. Inspection of the non-return arrangement in all the airpipes is a Load Line Survey item, and every airpipe should be regularly checked between surveys by ships' staff.

The positions of the air and sounding pipes of the *Regina Oldendarff* can be seen on Fig. 3.3. This shows each tank provided with two airpipes, one forward and one aft.

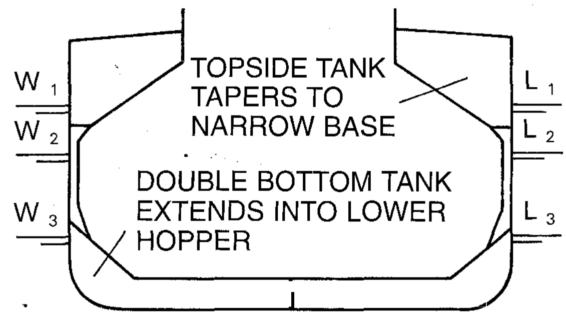
Sounding pipes: Every ballast tank is provided with a sounding pipe, normally located at the after end where the greatest sounding will be obtained, provided the ship is trimmed by the stern. At the base of the sounding pipe is a striking plate, a small section of doubled plating which protects the ship's shell plating from wear caused by the impact of the steel sounding rod, or the pipe may continue to the ship's shell, with openings cut near its base.

An unusual and practical feature aboard the *Regina Oldendorffis* the provision of additional hold sounding pipes on the masthouse tops (Fig. 3.3). These make it possible to take soundings of the holds to detect flooding, even when the decks are awash.

Tank gauges: Ballast tanks are often provided with remote reading indicators which show whether or not the tanks are empty, or with gauges which show the volume of ballast which the tank contains. Such devices are useful indications of the progress of ballasting or deballasting but must never be trusted completely. Upon completion of any ballasting process the tank contents must be measured with sounding rod or sounding tape to obtain a reliable measure of the contents. If there is any suspicion that the sounding rod has not reached the base of the pipe, which may be blocked by an old sounding plumb or by scale or sediment, the ullage should be measured by taking the reading at deck level when the rod is at the deepest sounding. The ullage can then be compared with its known or listed value which, on large ships, is likely to be the same as that for a number of other tanks.

Centralised ballast controls: On modern ships the ballast controls are likely to be centralised in a single position, perhaps with duplicate controls elsewhere. Such controls are likely to include remote switches for the valves in the ballast system and for the ballast pumps, along with gauges or indicators to show the contents of each ballast tank. The centralised controls may be found in a cargo control room, in the engine-room control room, on the bridge or in a masthouse.

BALLAST TANKS—THEIR POSITIONS—GRAVITATING



The topside tanks are high in the ship. When the ballast, lines are opened to the sea all the ballast in the topside tanks will gravitate to sea until the tank is empty, except, when the ship is floating at W_1L_1.

The double bottom tanks are low in the ship. When the ballast lines are opened to the sea the double bottom tanks will fill by gravity, except when the ship is floating at W_3L_3. '

FIG **7.1**

Double-bottom ballast tanks: It is normal for the double-bottom ballast tanks to extend into the lower hopper spaces, creating a tank with a tanktop which rises to a greater height in the wings (Fig. 7.1). These double bottom tanks are subdivided for strength purposes into small steel cells formed by vertical steel plates running athwartships and fore and aft (Fig. 7.2). The athwartships plates (called floors) and the fore-and-aft plates (named side girders)' have lightening holes cut in them at intervals to reduce the weight of steel used and to allow access. Drainage holes are provided at the base of the vertical plating to allow complete drainage of the tank, whilst similar holes at the top of plating allows free circulation of air. Movement through the tank for inspection or cleaning purposes is difficult in the smaller mini- and handy-sized vessels, because of the limited dimensions, though it becomes easier in large bulkers.

Topside ballast tanks: The topside, saddle or upper hopper ballast tanks stretch along the length of the ship's side and occupy the upper corners of the ship's hull (Fig. 7.1). There are several ways in which these tanks can be filled and emptied, and the method varies from one design of ship to another. The simplest method to describe is similar to that found in other ballast tanks: a ballast line runs to each topside tank from the engineroom and is used to pump ballast water into or out of the tank, from or to the sea, via the engineroom. This is the system installed in the *Regina Oldendorff.*

Dump valves: The usefulness of the topside tanks is increased when they are fitted with dump valves. Dump valves (drop, or screw down overboard drain valves) are ship's side valves, usually one to a tank, which are used to discharge the ballast from the topside tanks by gravity directly into the water alongside the ship. This is very useful when there is a requirement to discharge a lot of ballast quickly. A further advantage is that no pump is needed for the discharge. One exceptional situation in which dump valves are useful is when refloating a vessel after grounding. If all the topside ballast is dumped at one time the draft decreases rapidly and the prospect of refloating from a muddy bottom is increased. The facility is equally useful in routine deballasting when rapid deballasting is required, as is so often the case.

When deballasting by way of dump valves, care must be taken not to discharge ballast into barges lying alongside or on to the quay where sensitive equipment, power lines or stocks of cargo are located. Where available and where required chutes should be used to guide discharged ballast water down the ship's side.

Integrated topside tanks: Some topside tanks are fitted with no separate ballast lines, and with no dump valves, but are simply joined to the adjacent lower hopper and double-bottom tank by trunking. This system is clearly the cheapest to install and maintain, but is the least useful. The topside tank in this system is simply an extension of the lower hopper and DB tank. It can only be filled when the lower tank has been filled, and the DB tank cannot be emptied until all the ballast has drained from the topside tank. When there is a need to keep the lower tank empty for any reason—for example, to make the ship less stiff by raising the centre of gravity, or because the lower tank is damaged and leaking—the upper tank must be left empty, too.

An improved version of the combined topside and double-bottom tank is achieved when a gate valve is fitted in the trunking between upper and lower tanks. This permits the upper tank to be kept full while the lower tank is emptied.

Topside tanks for carriage of grain: A few bulk carriers, of which the *Regina Oldendorff* is one, are designed to carry grain in the topside ballast tanks. Loading grain in the topside tanks is an option which will be avoided where possible because of the great amount of careful cleaning which will be required both before loading the cargo, and after discharging it. (The carriage of grain in topside ballast tanks is described in Chapter 18).

Ballast pumping arrangements

Most bulk carriers are provided with at least two main ballast pumps. Normally one is used on starboard ballast tanks and the other on port ballast tanks, but these arrangements can be varied. The port pump can be used on starboard tanks, and the starboard on port tanks, and both pumps can be used together on large tanks such as ballast holds or the forepeak tank. For emergency use if a ballast pump fails there are usually other pumps such as a general service pump which can be used to pump ballast.

In addition to the main ballast pumps most bulk carriers except the smallest are provided with a ballast stripping system. This relies on a low capacity pump or eductor to pump out the strippings (the last few centimetres of ballast water) from the ballast tanks. On Cape-sized or larger vessels a separate stripping line to each tank may be provided, but this is rare in other bulkers. More often on Cape-sized, Panamax and handy-sized vessels the stripping is done by way of the main ballast line.

Mini-bulkers may be provided with no separate stripping pump or system, all the ballast being discharged by careful operation of the main ballast pumps.

The bilge and ballast-pumps in the engineroom of the *Regina Oldendorff* (Figs. 1.28 & 3.4) include a ballast pump, a similar ballast/bilge/general service pump, a fire/general service pump and a ballast stripping pump.

Quantity of ballast required for voyage

Most bulk carriers have a light ballast condition for use in fair weather, with all double bottom, hopper, topside wing and peak non-fuel tanks filled. The displacement in light ballast condition is typically 40-50 per cent of loaded displacement.

Most bulkers also have a heavy ballast condition for use when rough weather is expected or met. In this condition the above tanks are filled and in addition one hold is, or several holds are, flooded giving a displacement of 50-65 per cent of loaded displacement.

It is possible to change the amount of ballast which the vessel is carrying during the course of the voyage, but the matter should be considered beforehand since a ship with insufficient ballast will be slowed by the weather and may suffer damage, whilst a ship carrying too much ballast will be incurring extra expense as her fuel consumption will be higher and her speed may be reduced.

When strong winds-particularly strong adverse winds-and a heavy swell are expected it is prudent to carry maximum ballast to prevent the bow slamming and the propeller racing when the ship is meeting the swell.

In fair weather, significant savings in fuel consumption can be easily obtained, it is claimed, by carrying minimum ballast, and a major study of this subject[28] has identified the optimum minimum ballast condition. The propeller need be only immersed to 90 per cent of its diameter when the vessel is at rest, since the stern wave will immerse the propeller fully when the vessel is under way. The optimum forward draft in fair weather is more difficult to specify. It is necessary to strike a balance between the benefit of reduced forward draft and the loss of efficiency which results from increased trim. In addition, there will usually be a loss of propulsive efficiency at the draft at which the top of the bulbous bow breaks the surface.

The study suggests that a ship provided with a reliable and accurate fuel meter and speed log can become its own testbed to tune draft and trim in varying weather states so as to maximise 'metres per litre'[28] The benefits of tuning are likely to be greatest in fair weather conditions, whilst in moderate or heavy weather the vessel should be ballasted down. The transfer of bunkers is a more efficient way of improving trim than is the taking of additional ballast, since the former alternative requires no increase in displacement[35], but seafarers will treat this option with caution in view of the possible penalities for a mistake whilst transferring fuel.

A further study[35] by one of the same authors concluded that a very flexible and adaptable system of ballasting could be achieved if the ballast hold was always filled on ballast passages, with most other ballast tanks being kept empty except as required to

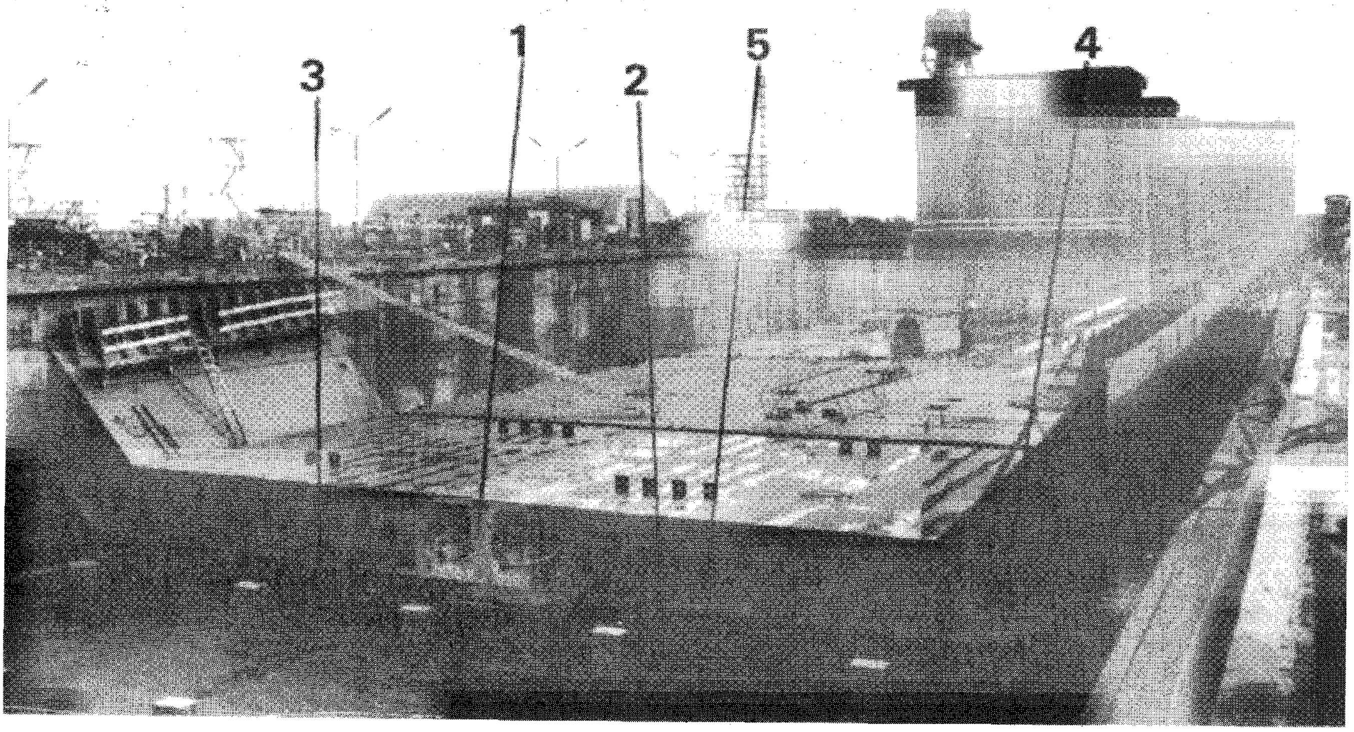


FIG 7.2 THE 60,000-DWT BULK CARRIER PORT VANCOUVER UNDER CONSTRUCTION BY BURMEISTER & WAIN

Photograph courtesy of Burmeister & Wain Skibsvaeft A/S

The picture shows the structure of the double-bottom and lower hopper tanks. Partly completed athwartships bulkheads can be seen in the background. The depth of the double-bottom tank below the tanktop is 2.05 metres.

Features shown:

1. Duct keel, with two main ballast lines running through it.
2. A transverse floor-one of the vertical plates fitted at intervals in the double bottom tank, which subdivide the tank and provide support for the tanktop.
3. Butt of side girder.
4. Lower hopper tank (part of the double-bottom tank).
5. Lightening hole. The double bottom is divided by the transverse floors, and by the side girders which run fore and aft. Movement about the double bottom, for inspection or maintenance purposes, is byway of the lightening holes.

Drainage of water ballast from the double bottoms occurs by way of small drain holes, not easily seen in the photo, at the base of each transverse floor and side girder. Similar holes at the top of each floor and side girder allow the movement of air and water when the tank is almost full.

avoid excessive bending moments and shear forces, to achieve optimum trim, or to increase displacement in the event of meeting adverse weather. An additional benefit of this method of operation would be the reduction of sediment taken into double-bottom tanks. This system of ballasting, with the ballast hold always filled on ballast voyages, is only attractive in trades in which the hold can become available for ballasting some time before the completion of discharge and where loading can proceed in other holds whilst the ballast hold is prepared for loading.

On some ships the filling of all ballast tanks for a ballast passage is forbidden because the longitudinal stresses are excessive when ballast holds, and adjacent ballast tanks, are all full. Such a ship is permitted to sail in the light ballast condition with all double-bottom and topside tanks full and the ballast hold empty, or alternatively in the heavy ballast condition with the ballast hold or holds filled but with specified adjacent topside tanks empty. Any such requirement will be plainly stated in the ship's loading manual.

Ballasting whilst discharging

Preparations for ballasting: When discharging a homogeneous cargo a common practice is to instruct the stevedores to discharge half the contents of all holds before completing the discharge of any hold. This is particularly important to keep stresses to an acceptable level if the vessel has been loaded only in alternate holds with high density cargo.

It may not be possible to commence with the discharge of half the contents of all the holds because the cargo consists of several different products or grades or is even destined for two different ports. In these cases, the ballasting sequence must be planned with care to minimise longitudinal stresses and to ensure that the permissible stress limits are not exceeded.

Before commencement of ballasting it is necessary on some ships to raise or open the ballast tank ventilators or airpipes to allow air to be exhausted as the ballast water enters the tank. It is also important to note where ballast water may overflow. Ballast water which can overflow into part-filled cargo holds or over the ship's side into barges or on to the quay can be a source of substantial claims.

If there is the slightest danger of an overflow causing damage or giving rise to a claim (not necessarily the same thing), then such overflow must be avoided by stopping the filling of the tank just before the tank is full. To ensure that this is achieved the ballast pumps should be singled up, or reduced to minimum speed, when the tank is nearly full and an officer should be stationed by the tank ventilator with a walkie-talkie radio, which gives him direct contact with the ballast pump operator. When the officer sees that the tank is about to overflow he must instruct the pump operator to stop the pump. If necessary the filling of such tanks can be completed when the vessel is at sea.

It is important to remember that hold structures are regularly damaged by grabs during discharge. If a hole has been punched in a tank during discharge then ballast water will pour on to the cargo in the hold when the tank is ballasted. Before ballasting is started the holds should be inspected as far as possible to ensure that no damage has been sustained, and the tank boundaries should be regularly viewed to detect any leakage of ballast water whilst ballasting continues.

Precautions whilst ballasting: A full ballasting plan, consistent with the cargo discharge plan, complying with shear force and bending moment limits and taking account of any draft and airdraft limits should be prepared in advance. The Nautical Institute has recommended that such plans should be lodged with a shore authority as a matter of routine every time that the vessel loads or discharges. (For a fuller account of this subject see Chapter 9).

Instances have been recorded in which the internal structures of ballast tanks have been damaged as a result of ballasting at too high a rate. Damage can occur when a full tank is overpressurised, a condition which arises if water is pumped into the tank faster than it can overflow out of the tank through the airpipes. This is most likely to occur if the tank has an airpipe which is blocked through freezing, but could possibly occur if two pumps were used to fill a single tank, or if an airpipe were damaged. Risk of damage will be reduced if tanks are always topped-off at a reduced pumping rate.

When berthed in a river ballasting is best done on the flood tide, when there is less sediment in the water. This will result in less mud in the ship's ballast tanks.

Ballasting—the first stage: It is normal to commence ballasting by filling double-bottom tanks, and this can be done by gravitating—opening the sea valves in the ballast system and allowing the water to flow through the ballast pipes and into the chosen tanks under the effect of gravity. The speed of filling will depend upon the head of water: this corresponds to the draft of the ship. If the draft of the ship is less than the height of the tops of the lower hopper tanks (Fig. 7.1), then the tanks can never be completely filled by gravitating and it will be necessary to complete the filling by pumping. The benefits of filling a tank by gravitating are threefold. There is no possibility of the tank overflowing and causing damage, no power is required so there is a cost saving, and the filling will stop naturally when the level of the outside water is reached so it is not necessary to monitor the process continously.

The sequence of filling the double-bottom tanks will be decided by the sequence of discharging the cargo holds. Where all holds are discharged simultaneously and where the cargo is of low density, the longitudinal stresses will be low and it will be possible to adopt any reasonable sequence of filling the double-bottom tanks.

Another factor to bear in mind is the vessel's trim. It is always preferable to maintain a trim by the stern so that reliable soundings can be obtained, for purposes of efficient drainage throughout the ship, and for the convenience of the engineers. Where possible this trim should be ensured by a suitable cargo discharging programme, but ballast may be needed to assist the process. Where all holds are not discharged at the same time and some remain full, it will usually be necessary to reduce the longitudinal stresses by taking full ballast in the double-bottom and topside tanks surrounding the holds which are first discharged.

Ballasting-the second stage: As the remaining

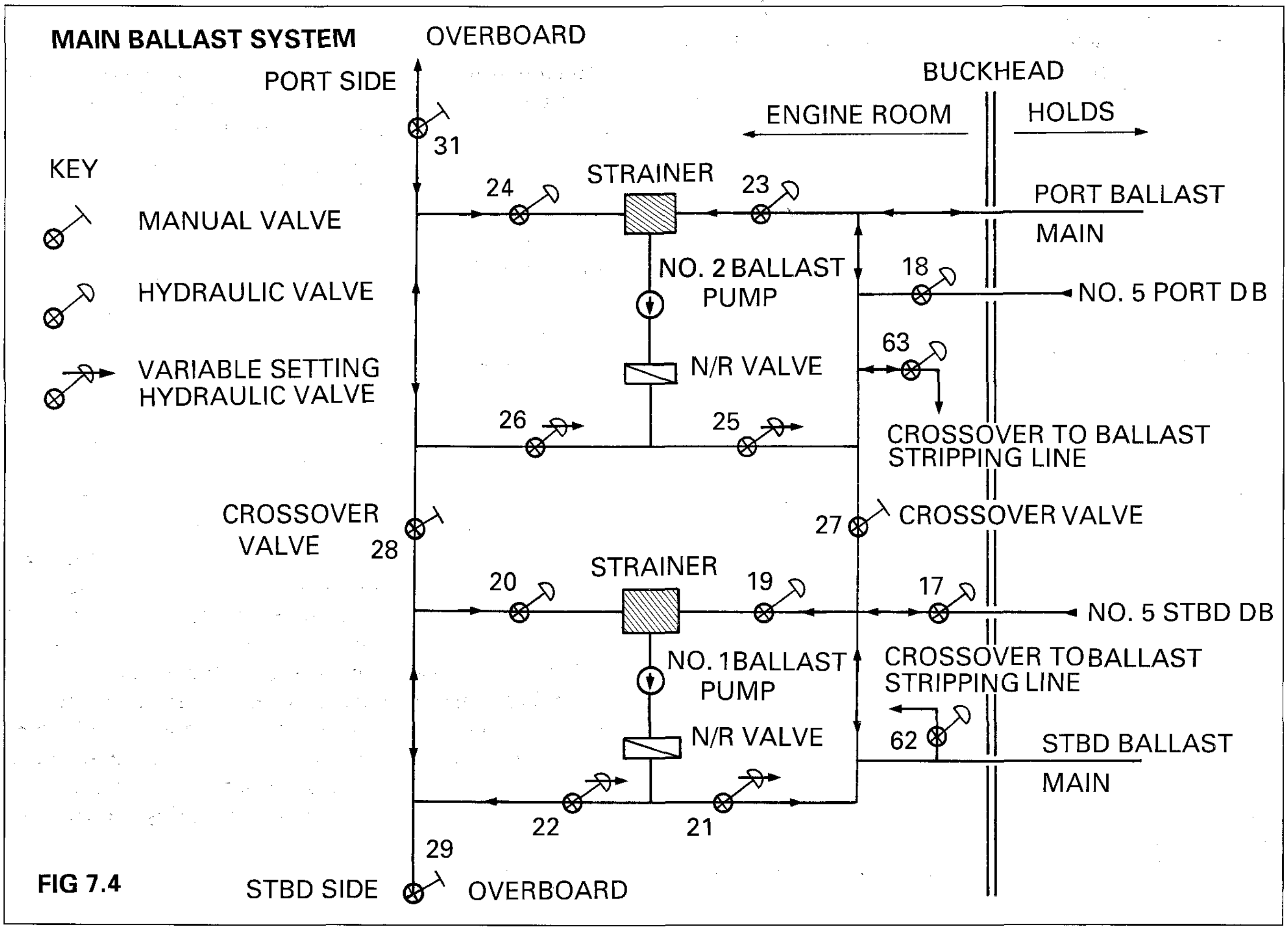

MAIN BALLAST SYSTEM
OVERBOARD
PORT SIDE
BUCKHEAD
ENGINE ROOM
HOLDS
KEY
MANUAL VALVE
HYDRAULIC VALVE
VARIABLE SETTING HYDRAULIC VALVE
31
24
STRAINER
23
PORT BALLAST MAIN
NO. 2 BALLAST PUMP
18
NO. 5 PORT DB
63
N/R VALVE
26
25
CROSSOVER TO BALLAST STRIPPING LINE
CROSSOVER VALVE
28
27
CROSSOVER VALVE
20
STRAINER
19
17
NO. 5 STBD DB
NO. 1BALLAST PUMP
CROSSOVER TOBALLAST STRIPPING LINE
62
N/R VALVE
STBD BALLAST MAIN
22
21
29
STBD SIDE
OVERBOARD

FIG 7.4

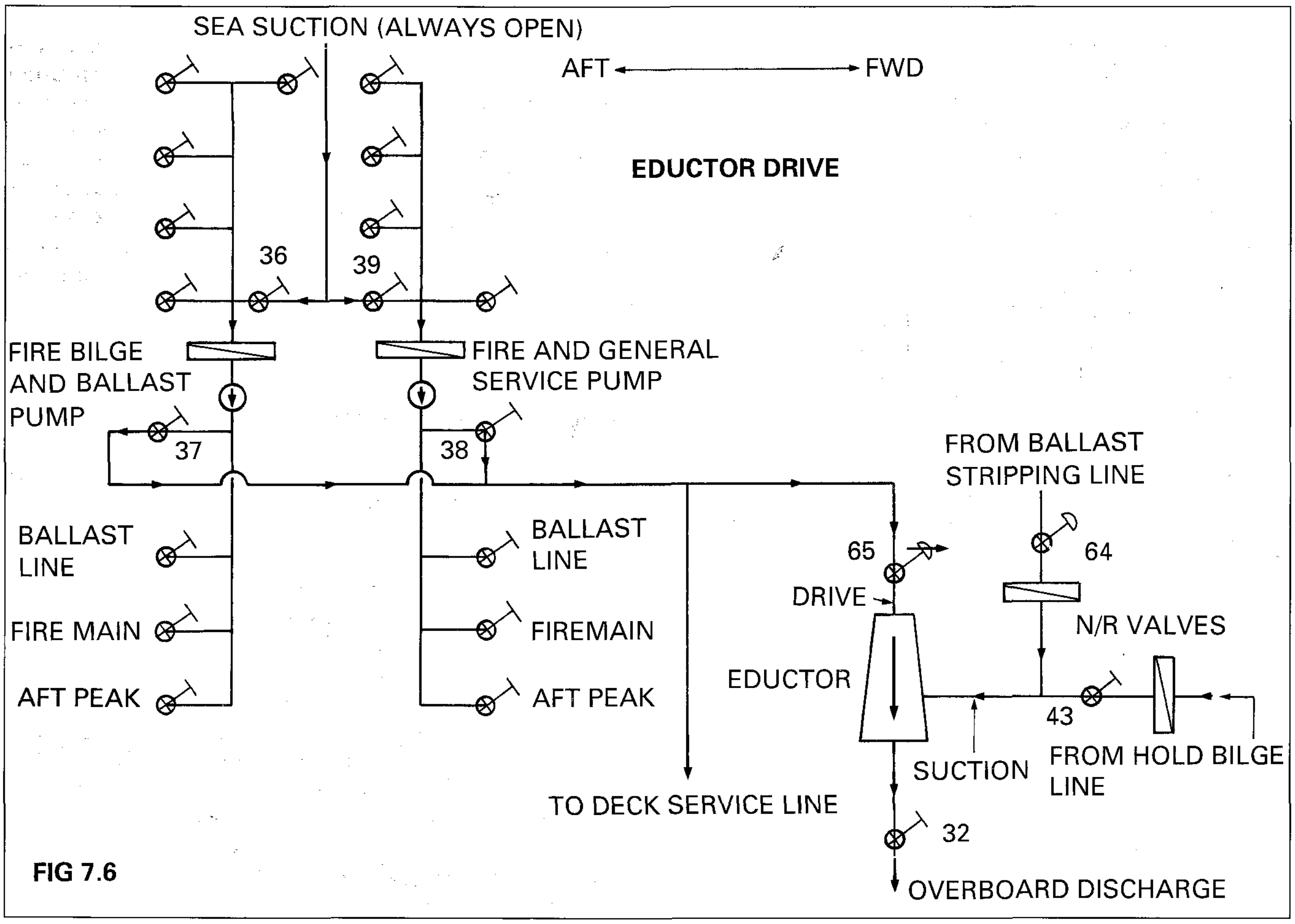

SEA SUCTION (ALWAYS OPEN)
AFT
FWD
EDUCTOR DRIVE
36
39
FIRE BILGE AND BALLAST PUMP
FIRE AND GENERAL SERVICE PUMP
37
38
FROM BALLAST STRIPPING LINE
BALLAST LINE
BALLAST LINE
65
64
DRIVE
FIRE MAIN
FIREMAIN
N/R VALVES
EDUCTOR
AFT PEAK
AFT PEAK
43
SUCTION
FROM HOLD BILGE LINE
TO DECK SERVICE LINE
32
OVERBOARD DISCHARGE

FIG 7.6

quantity of cargo diminishes, and once the DB tanks have been ballasted, the topside tanks must be filled. They are at too great a height to be filled by gravitation so must be pumped full, taking the precautions already mentioned for the double-bottom tanks. The forepeak and afterpeak tanks will be filled as required during the first or second stage of ballasting.

Ballasting—the third stage: The third stage of ballasting is the filling of the ballast holds of ships which have them. Ships with no ballast holds, such as the *Regina Oldendorff,* are fully ballasted upon completion of stage 2 of the ballasting. Most other ships will, on completion of stage 2, be fully ballasted to the light ballast condition. Filling the ballast hold or holds is usually optional and is undertaken to achieve the heavy ballast condition. If this condition is chosen each ballast hold must be prepared for ballasting (a process which is fully described in Chapter 5).

When the hold has been cleaned as circumstances require any blanks and cover plates must be removed from the ballast line to allow ballasting and deballasting and the bilge line must be blanked off to prevent the flooding of other compartments. Some classification societies prohibit ships' masters from operating their ships with ballast holds filled to between 20 per cent - 70 per cent of capacity, and holds if ballasted at sea should always be fully ballasted to avoid damage from sloshing. At the commencement of the voyage the ballast holds should be filled to the coaming, a process which is often achieved with the hatch covers still open for easy observation of the filling. When filling has been stopped the hatch covers must be closed and well battened down. The ballast hatch covers on some ships are provided with four breather valves which must be open when ballast is carried.

Ballasting—the fourth stage: Certain large bulk carriers are equipped with some additional ballast holds which can be ballasted only in port to reduce the airdraft. Such holds are not strong enough to be fully ballasted, and can only be filled to a stated level, perhaps half the capacity of the hold. The ballasting reduces the vessel's airdraft, so that the grabs and bulldozers can clear the coaming when being lifted in and out of the working holds. The ballast must be disharged from these holds before the vessel puts to sea.

Ballasting rates: Officers will quickly become familiar with the ballasting rates which can be achieved with one or with two ballast pumps or by gravitating. Nominal ballasting and deballasting rates, based upon installed pump capacity and ballast capacity, vary considerably from ship to ship, but a nominal time of 10-15 hours is typical for the full deballasting of a large range of ship sizes. Actual times are longer for operational reasons, though it is reported to be common for terminal operators and charter party clauses to require a vessel to deballast completely within 24 hours.

Ballast management on passage

Whilst on the ballast passage it is tempting to ignore the ballast tanks in the belief that nothing can go wrong with them, but this is not a prudent attitude to take. Ballast tanks when full should continue to be sounded or ullaged at least once a day as a means of detecting any leakage, and the soundings should be recorded as measurements, not simply as 'Full'. Leakage from ballast tanks into holds will usually be detected during hold inspections, but leakage from ballast tanks into void spaces or through the ship's side into the sea is not easily detected by any means other than the monitoring of soundings.

During the course of the voyage it is likely that a small part of the contents of ballast tanks will slop out of the tanks by way of the air pipes, particularly if the ship moves in a seaway. For this reason it is common practice to press up (i.e., fill and overflow) all ballast tanks before arrival in the discharging port. However, the pressing up of a tank does not guarantee that it is full, and it is still advisable to sound all tanks, to apply the appropriate corrections to the soundings and to take account of the density if the exact weight of the contents is required.

During the course of a ballast voyage there are several possible reasons for changing ballast. The most important of these is the restriction, introduced round about 1990 by Australia, New Zealand and Canada, upon the discharge of untreated ballast water from the ports or coastal of waters of other countries.

A second reason for changing ballast arises when the ballast carried is fresh or almost fresh water and the ship is going to a loading port in a cold climate, where fresh or brackish ballast water is liable to freeze in the tanks and to block sounding and airpipes and ballast valves. Before reaching freezing conditions fresh water must be exchanged for salt water.

When a ballast hold has been filled at the start of the ballast voyage with dock water which is dirty or sediment laden and a clean hold is required in the loading port, for the carriage of grain for example, the hold should if possible be emptied, cleaned and refilled at sea. Individual ballast tanks may be emptied or filled during a ballast passage, provided stress and stability considerations permit, for purposes of adjusting draft, trim and list, or for tank maintenance.

When making a complete change of ballast in the open ocean the first objective must be to devise a deballasting/ballasting programme which ensures that the at-sea stress limits are never exceeded and that adequate positive stability is maintained at all times. An important further requirement must be to minimise the sloshing of water in part-filled tanks and holds. This requires that the changing of ballast is undertaken in the calmest weather available. Since swell is even more difficult to predict that wind, and since a full change of ballast may take 36-48 hours of continuous work, which may be spread over four normal working days, this will sometimes be a difficult requirement with which to comply. In addition the ballast change programme should be made as simple as possible to execute, for the convenience of the ship's personnel responsible for the process.

A programme for a complete change of ballast aboard a Cape-sized bulk carrier is at Appendix 7.3. A ballast tank on the port side and the matching tank on the starboard side should be emptied or filled at the same time. No. 2 starboard double-bottom tank should not be pumped out at the same time as No. 4 port DB tank, even if they have the same capacity. The ship will remain upright, but the uneven distribution of weight about the ship's centreline will risk twisting her hull and damaging her. (This problem is discussed more fully in Chapter 26.)

Aboard some bulk carriers a change of ballast in the ballast holds is achieved by overflowing the hold continuously for 12-24 hours, but trials[51] have shown that this does not achieve a complete change of ballast. Even after exchanging three tank volumes some 5 per cent of the original water and up to 25 per cent of plankton sediment is likely to be retained.

It has been reported[51] that the design of some bulk carriers makes it impossible to achieve a complete ballast change by pumping out and refilling each pair of ballast tanks in turn, without exceeding the maximum permitted at-sea stress limits. The owners of such vessels have to adopt alternative measures, such as the use of approved chemicals, to comply with the requirements of the discharge port authorities.

Restrictions on the discharge of ballast

About 1990, to prevent the spread of harmful organisms in ballast water, restrictions were introduced by the authorities for Australia, New Zealand and the North American Great Lakes.

In Australia the restriction, at the time of writing (1993), takes the form of voluntary guidelines which discourage the discharge of ballast water or sediment which may contain harmful organisms. Shipmasters are advised to obtain a certificate stating that the waters where the vessel ballasted contain no toxic dinoflagellates (harmful organisms), or to treat the ballast water with approved chemicals during the voyage. Alternatively, they may carry out a complete change of ballast water in clear tropical waters before arrival in Australian coastal waters or make arrangements to discharge ballast ashore to approved reception facilities, where such exist. Consideration is also being given to the possibility of heating ballast water to destroy harmful organisms. Each of these options presents some difficulties, but when fair weather is experienced on the voyage the most straightforward alternative for most vessels is to make a complete change of ballast.

The Australian procedure for requesting radio pratique has an optional supplementary section. This gives the master an opportunity to answer questions, and thereby to declare how he has complied with the restrictions.

Shipmasters are advised to ensure that full signed records are maintained, written at the time of each occurrence, of the times and positions where ballast is taken, changed or discharged, the tonnage pumped and tanks used, the salinity of the ballast taken, and of any chemical treatment given to the ballast. There is a real danger of overstressing the ship and damaging her if ballast is changed at sea in rough weather, and for this reason any requirement to change ballast, with no alternative offered, must be viewed with serious concern.

Deballasting

Deballasting before berthing: A full deballasting plan, consistent with the cargo loading plan, complying with shear force and bending moment limits and taking account of any draft and airdraft limits, should be prepared in advance. The Nautical Institute has recommended that such plans should be lodged with a shore authority as a matter of routine, every time that the vessel loads or discharges. (For a fuller explanation of this matter see Chapter 9.)

When planning the deballasting of their vessel, the master and chief mate will take account of several significant operational considerations. Important amongst these is the height of the loading arm (the height of the loader above water level, or the airdraft in the berth). If the ship discharges too much ballast before she commences loading she will rise too high in the water, and the loading arm will be unable to extend over the coaming to commence the pouring of cargo into the hold. The height of the loader, taken in conjunction with the ship's dimensions and trim, and the anticipated height of tide, will decide the maximum amount of ballast that can be discharged before arrival. In many instances the master will decide to do no deballasting before berthing, to ensure that the vessel preserves a draft and trim which is safe for manoeuvring in all circumstances.

Stress and stability must be considered, as in all cargo and ballast operations, and if the ship has reached a sheltered anchorage or layby berth where she is not exposed to swell, then it is permissible to use the in-port stress limits for the calculations. However, The Nautical Institute recommends that the lower at-sea stress limits should where possible be used for all calculations to provide an increased margin of safety. A stern trim is essential for the taking of accurate soundings and for the efficient stripping of ballast tanks and must be maintained throughout loading.

Other factors will also influence the master's decision as to how much ballast, if any, is to be discharged before berthing at the loading berth. If the winds are strong and the berth is not well sheltered or well orientated he may require to maintain maximum draft for the berthing manoeuvre. The port regulations may specify minimum drafts, trim and propeller immersion. On the other hand, a loading plan which calls for the loading of cargo in a ballast hold will require that hold to be deballasted and prepared for loading quickly, before berthing if possible.

If other factors permit the discharge of ballast before berthing, it is always in the interests of a speedy loading that some ballast should be discharged. Loading at most berths can be accomplished faster than the deballasting rate, so deballasting delays can be reduced or eliminated if the ship is partly deballasted before berthing. Since it is sensible to meet and resolve problems as soon as possible, the best tanks to deballast before berthing are those which are most likely to present difficulties for the ship. These are the ballast holds, if they are to be loaded fairly early in the loading sequence, and then the double bottom tanks. The topside and peak tanks taper steeply to the tank bottom, which assists drainage, but the double-bottom tanks have extensive flat bottoms in which a small sounding (say, 15 cm) can represent a considerable tonnage of ballast. These double-bottom tanks are usually the most difficult to deballast and it is helpful if some or all can be pumped out before berthing when this can be done without risk to the ship.

Some of the factors mentioned above are reasons for the discharge of some ballast before berthing.

Others are reasons for retaining ballast until the ship is berthed. The master must seek to strike the correct balance in each loading port, having regard to the circumstances of the case.

Deballasting sequence: The deballasting sequence has already been indicated and is dictated by the requirements to limit stresses, maintain a stern trim and an acceptable air draft. Ballast holds, where provided and full, will be discharged first. Double-bottom tanks will be discharged next. Topside tanks will be discharged after double-bottom tanks, except where stress considerations dictate that they are discharged at the same time as the adjacent double-bottom tanks. Peak tanks will be discharged last. Within this framework it will generally be the case that double-bottom tanks and topside tanks will be discharged when the adjacent hold is being loaded.

Keeping to the programme: A variety of operational problems can cause the speed of deballasting to slow, particularly with inexperienced operators and/or older ships. When this happens there is a danger that the deballasting will get out of step with the loading. This must not be allowed to happen; the deballasting must continue in step with the loading to ensure that the ship is not exposed to stresses which have not been calculated and that longitudinal stresses are not exceeded. If a deballasting step has not been completed the loading must be stopped until the deballasting is again in step although, if the quantity of ballast remaining in the tank is small, it is acceptable to move to the next step in the programme and to return to finish deballasting the uncompleted tank at a later stage.

It will always be easier to keep to the deballasting programme when that programme is a realistic one. When preparing the programme it is best to assume the highest possible loading rate and a moderate deballasting rate. This should ensure that there is adequate time for each deballasting step, even if minor problems are met.

Pumping ballast: On some bulkers the deck officers are responsible for ballast operations. On other ships they tell engineroom staff what ballast is to be pumped and the work is carried out by an engineer or pumpman. In both cases deck officers should have a good understanding of the processes involved.

As an example, the deballasting of the No. 5 port double-bottom tank of a Cape-sized bulk carrier is described, with reference to the schematic diagram of the ballast pumping arrangements of such a vessel (Fig. 7.4).

Ballast pumps are normally centrifugal pumps driven by electric motors. Gauges show the pump discharge pressure in kgs/cm^2, the pump load in amperes and the pump suction pressure in kgs/cm^2. The variable setting hydraulic valves can be set open, shut or part way between the two extreme positions. Each valve has a gauge which shows its setting. The manual valves can also be set in any position and have telltales to show their settings.

To deballast No. 5 port DB tank proceed as follows:

1. Before starting any ballast pumping operation inform the engineers of the intended pumping, and confirm that sufficient electrical power is available to commence and complete the operation.
2. Open fully valves 18, 23, 31.
3. Open discharge valve 26 until it is 15 per cent open.
4. All other valves on the port side and crossover valves 27, 28 should be closed.
5. Make the pre-pumping checks in accordance with the manufacturers' recommendations (Appendix 7.5).
6. Press the start button on the port ballast pump (a centrifugal pump which takes about six seconds to pick up speed) and when the pump is running open the discharge valve (26) slowly. As the discharge valve is opened the discharge pressure will decrease. Steady the discharge pressure by slowly opening the discharge valve until optimum pumping is achieved (with the manufacturer's recommended discharge pressure—3.0-3.5 kg on this vessel).
7. Check that the ammeter shows maximum load (about 400 amps on this vessel), and confirm that the ballast suction pressure reading is steady.
8. Always check by sounding or by detecting air being sucked into the tank airpipes that the level of ballast in the tank is falling. Mistakes are common when people are tired, overworked or inexperienced, and it is impossible to tell from the pump's performance alone the origin or destination of the water it is pumping.
9. The discharge pressure should remain steady and not fluctuate. As the deballasting continues the water level in the tank will fall. This means that the head of water feeding the pump is reduced. Continue to adjust the discharge valve (26) by gradually closing it to maintain the maximum rate of pumping. This is indicated by a high amps reading, and a good, steady discharge pressure.
10. Do not close the discharge valve to below 15 per cent. Below this setting it becomes likely that the pump will overheat and trip out because of the high temperature, or will damage the pump casing.
11. When the discharge valve has been closed to 15 per cent, the amps are low and the discharge pressure is fluctuating, the tank is nearly empty. At this time another full tank should be opened and No. 5 port double-bottom should be closed, or the ballast pump should be stopped.

Stripping ballast: When No. 5 port double-bottom tank has been pumped out, a quantity of water (the strippings) will remain in the tank. All but the smallest bulkers have a stripping pump or eductor to remove the strippings. Eductors rely upon the Venturi principle. They have no moving parts, and are operated by a powerful water jet which is passed through the eductor, and which sucks the ballast water with it. An eductor requires no filters and can be used to discharge water which is laden with sediment and mud. Another advantage of the eductor is that once it has been started it requires very little attention and will come to no harm if left to run on an empty tank.

The eductor in a typical Cape-sized bulker is situated in the engineroom and driven by a general service pump which can pump at two rates. The pump has two impellers which can be set in series (to pump at high pressure), or in parallel (to pump at high capacity). The series or parallel setting is selected by movement of an external lever at the side of the pump. The series setting should be used for driving the eductor. This gives a high discharge pressure from the pump, which causes a strong suction on the eductor intake and gives an eductor capacity on the Cape-sized vessel of 200 tonnes/hour.

The procedure for using the eductor to remove the stoppings from the same No. 5 port double-bottom tank of the Cape-sized bulker can be followed in the schematic diagram (Fig. 7.6), and is as follows.

1. Choose to use the fire, bilge and ballast pump to drive the eductor.
2. The sea suction valve to the general service pumps must be open. It is normally kept open at all times, as these are also the ship's main fire-fighting pumps.
3. Open valves 36, 37, 65, 32.
(Alternatively, the fire and general service pump can be used for this task. In that case the valves to open would be 39, 38, 65 and 32).
4. Start the pump.
5. When the eductor is running read the pressure gauge at the eductor suction valve to confirm that a good suction has been obtained.
6. When a good suction has been obtained open valve 64 to the ballast stripping line. (Most bulkers except the largest have no separate stripping lines to the ballast tanks. The procedure followed is just the same, but the stripping is done through the main ballast lines.)
7. Check the tank sounding and confirm that the level of water is falling.
8. Tanks should be educted one at a time. If a pair of tanks are educted together the eductor will lose suction and pump air from the time that the first tank is empty.

On ships equipped with stripping pumps instead of stripping eductors, the stripping is similar to the main pumping but uses pumps of lower capacity. Two problems may be met with stripping pumps which do not occur with eductors. The pumps are equipped with strainers to prevent damage to the pumps by mud and grit which could enter them. If the ballast water is dirty the strainers may become blocked. This slows the pumping rate and the strainers must be changed or cleaned.

When a stripping pump is being used it must be watched in order to adjust its settings as the pressure changes and the tank must be watched to detect when it is empty, since the pump will be harmed if it continues to pump on an empty tank for more than a few minutes. In this case the stripping process requires more supervision than with an eductor.

Gravitating ballast: Gravitating ballast is the process of letting ballast which is high in the ship run out into the sea under the influence of gravity, without the need to use a pump. The same process can be used to fill tanks which are below the waterline, from the sea.

The process of discharging the ballast from No. 5 port topside tank in a Cape-sized bulk carrier can be followed from the schematic diagram (Fig. 7.4). No. 5 port topside tank in this ship is connected to No. 5 port double-bottom tank, and is filled and emptied through the double-bottom tank, byway of valve 18. If the tank was on a separate ballast line the valve for that line would have to be opened.

The procedure in this case is as follows.

1. Open fully the No. 5 port double-bottom tank valve, 18.
2. Open fully valves 25, 26, 31.
3. Valves 24, 23, 63, 27, 28 and all other port side tank valves must be closed.

This procedure runs the ballast through the discharge side of the main ballast pumps. The process is recommended because it avoids running ballast through the pump strainers on the suction side of the pump, and avoids unnecessarily pressurising the pump casing.

Achieving good deballasting

Opening of airpipe cowls: Before deballasting can commence, the ballast tank airpipes must be open. Aboard modern bulk carriers the airpipes are usually designed to be always open, but in older vessels the airpipe cowls may need to be raised, or opened, to admit air into the tank. If this is forgotten the ballast pumps will begin to labour as they try to remove water from a sealed tank, or the structure of the tank may be damaged as a vacuum is created within it.

Keeping ship upright: If the ship develops a list when loading and deballasting the effect may be caused by bad distribution of cargo, or it may be a fault with the deballasting, causing one of a pair of tanks to discharge more slowly than the other. If the fault is in the deballasting, the soundings will show that one tank is more full than the other and the fault must be found and corrected. If the list is the result of unbalanced loading of the cargo, the operator of the shiploader must be instructed to distribute the cargo so as to keep the ship upright whilst loading. An unplanned list will make deballasting more difficult and is likely to cause uneven discharge of ballast, thereby encouraging unbalanced loading of the cargo and exposing the ship's hull to additional stress.

Optimum trim and list: It is almost impossible to pump dry all the ballast tanks of a bulk carrier, but when such a vessel is carrying a deadweight cargo she ought to be carrying only the absolute minimum of ballast water, since the more stoppings she carries, the less cargo she can lift. Achieving a good discharge of ballast requires a combination of competence, thoroughness and good organisation, and also a clear understanding of the physical positions of the ballast suction and the sounding pipe within the tank. The ship's pumping plan can be useful in providing an understanding of the layout of the tank, but a conscientious officer will seek an early opportunity to enter some of the ballast tanks to view the pumping arrangements for himself.

It is normal for the ballast suctions in double-bottom tanks to be situated in the inboard after corner of the tank. This is true for the *Regina Oldendorff,* as can be seen from her pumping plan (Fig. 3.3). To achieve the maximum discharge of ballast from No. 2 double-bottom starboard wing ballast tank the vessel should be trimmed by the stern and listed to port, thus tipping any ballast which remains in the tank towards the position where the suction is located. On the *Regina Oldendorff,* the sounding pipe is situated close to the ballast suction, so that an accurate measure of the depth of water at the suction can be quickly obtained.

The factors which govern the deballasting and stripping on most bulkers are the following:

- The ship should have a good stern trim throughout deballasting.

- The ship should be kept upright throughout the main discharge of ballast.
- On most bulkers stripping can only be done when main pumping is finished, or interrupted, because both processes use the same lines.
- Stripping can usefully continue with the ship upright so long as the tank sounding shows water.
- Final stripping on most ships is best done with the ship listed.

Good stripping of the double-bottom tanks takes time and cannot be done effectively at the end of loading, when the ship is trimmed even keel or nearly so. Every opportunity must be taken during interruptions to the main ballast pumping to continue with the discharge of the strippings, to reduce them to a low level before final stripping.

The final stripping of the double-bottom tanks is best done with the ship trimmed well by the stern, and listed 2-3 degrees. The ship can be listed to port, say, using a topside tank. The loading foreman must be informed when this is done and asked to continue to pour the cargo on the ship's centreline to avoid an uneven spread of cargo across the ship. Once the ship is listed to port, all the starboard double-bottom tanks can be stripped dry. By the time that the final tank is stripped dry (for example, No. 5 starboard double-bottom on the *Regina Oldendorff),* more water will probably have trickled through the tank floors and side girders to the suction in the first tank (for example, No. 1 starboard double-bottom on the *Regina Oldendorff).* Any starboard double-bottom tanks which are again showing a sounding should be stripped for a second time. Then the vessel must be listed to starboard, and the process repeated with the port double-bottom tanks.

The topside and peak tanks taper down to a very small area at the base of the tank where the suction is situated and normally present no problems in stripping. Whilst loading and deballasting the ship should never be allowed to go by the head. In this condition the discharge of ballast is more difficult, final ballast strippings cannot be pumped out and accurate soundings cannot be obtained.

Preventing ballast pumps from tripping: Bulk carrier ballast pumps are usually centrifugal pumps driven by electric motors, with capacities appropriate to the size of ship, a Panamax vessel probably being provided with two x 1,000 tonne/hour pumps, and a handy-sized vessel with two x 500 tonne/hour pumps. When a ballast pump is given a tank full of ballast water to pump out it will operate efficiently until the tank is nearly empty, provided that its performance is monitored and adjusted as necessary. To maximise the pump discharge the load (the pump amperes) should be monitored regularly (say, every half hour) and maintained at the makers' recommended value by adjusting the pump outlet valve.

When the depth of water in a double-bottom tank is reduced to 15-20 cm the flow of water to the suction will start to be interrupted, as the ballast water cannot flow fast enough across the base of the tank, through the drain holes in the floors and intercostals. In consequence the pump will begin to pump a mixture of air and water.

Modern pumps are fitted with degassing devices which enable them to keep pumping when air is mixed with the water. The degassing is effected by a vacuum pump, which may serve one or several ballast pumps. When air starts to pass through the ballast pump the vacuum pump is switched on automatically and removes it. When the ballast pump is again pumping water the vacuum pump is switched off automatically. In older vessels, where the ballast pumps are not fitted with degassing devices, the pumps will race and then trip (i.e., cut out, or switch off) when they gas up.

If the pump frequently cuts out, the deballasting becomes very inefficient and there are several methods by which the problem of gassing up can be reduced. One method is to provide the pump with a moderate flow of water from another source. For example a suitable sea valve in the engineroom or the suction valve from a full ballast tank can be cracked open (i.e., opened a little), permitting a small flow of water to the pump will be sufficient to prevent it from racing and the pump will continue to run and to take smaller quantities of water from the near-empty tank, as well as from the other source which has been cracked open. If this process is done carelessly, with the valve from the full tank or the sea opened too wide the result will be that water from this second source will flood back into the nearly empty tank, which is the opposite to the desired result!

Another cause for the ballast pump to trip is if the ballast suction in the tank becomes blocked with mud—the sediment which has settled out of the ballast water in the tank. Sediment in tanks can build up to substantial levels during a period of months or years. Where sediment is suspected of being the cause of a stoppage of discharge the quickest way to clear sediment from around the suction is to flood water back into the tank from another tank with a good head of water, or from the sea. The rush of water into the tank will wash the sediment away from the suction, but this, of course, is only a temporary solution. When sediment is causing problems in a tank, traces of mud will probably be seen on the sounding rod.

Leaking ballast line: A less common cause for difficulties in deballasting is a hole in a ballast line. So long as the hole in the ballast line is below the level of water in the tank, the system will perform normally, but once the water level has dropped below the hole, the system will start to take in air and the pump is liable to gas up and trip. Some vessels have expansion joints in the ballast lines, and if an expansion joint leaks the effect is the same as if the line has a hole in it. Such a leak should be suspected if difficulty is regularly experienced in pumping out the last 0.5-1.0 metres of ballast in a tank, and if the sounding in an after tank falls slowly whilst a forward tank is being discharged, or rises slowly whilst the forward tank is being filled.

The leak can quickly be found by inspecting the ballast line within the after tank whilst the forward tank is full and the tank valve is open. Under these conditions water will be squirting out through the leak. Repairs to a leaking expansion joint can be effected by tightening or renewing the bolts, or by wrapping the joint temporarily in plastic sheeting.

An unusual explanation for difficulties should only be considered once the common explanations have been tested and discarded. On most occasions the pump trips because the water cannot flow to the suction fast enough, or because mud is blocking the suction.

Investigation of deballasting problems: When difficulties with deballasting are experienced, time is often spent trying to deduce the cause of the problem. It is sometimes impossible to make a physical inspection and then it is necessary to rely upon experiment and experience, both of which are useful tools. Physical inspections are also valuable. Aboard a mini-bulker which had no stripping pumps and where all deballasting was done with the main ballast pumps, the pumps used to lose suction when the sounding was still 40 cm—the height of the bottom of the lightening holes.

The engineers believed that the drainage holes in the floors and side girders were blocked with mud. The tank was opened up and the pump was started with the water height 40 cm, and the true problem was immediately seen. When the pump was pumping at full speed it emptied the small bay where the suction was located in two or three seconds, much faster than the water could flow into the bay through the drainage holes, which were not blocked. The only way that the tank could be pumped dry was by reducing the pumping rate.

Precaution when deballasting: When ballast is discharged from topside tanks by way of dump valves (otherwise known as drop valves) the process looks after itself. This is convenient for ship's personnel, but is thought to have resulted[33,34] on numerous occasions in personnel forgetting to close the dump valves after all ballast has been discharged. This can result in water re-entering the topside tanks, and flooding from there into the double-bottom tanks in ships where topside and double-bottom tanks are joined. At the worst this could result in serious difficulties or loss of the ship. At the least it could cause the carrying of unnecessary ballast, and reduction to the cargo lifted. It is recommended that the closing of all dump valves immediately on completion of deballasting be checked and logged.

A simple reminder of the setting of the dump valves is for each valve to be fitted with a rope lashing. When the valve is shut it must always be lashed to the ship's side rail. When the valve is open the lashing must be left hanging loose. This system is to be recommended.

Importance of good records and thorough, methodical approach: Whilst deballasting, the object of the chief mate and his colleagues is to ensure that every ballast tank is empty, or as close to empty as is humanly possible, by the time that loading is complete. The prospect of achieving that objective will be greatly improved if each duty officer is competent, thorough and methodical. Communication with the loading foreman and with the ship's pumpman, if there is one, should be prompt and efficient. Records of soundings obtained and of stages in the deballasting should be carefully and accurately recorded, so that they can easily be checked by colleagues.

When the deballasting of a tank has been started the airpipe should be checked to verify that air is being sucked in, thus confirming that water is being pumped out. Tanks which have been deballasted and recorded as empty should be rechecked at a later time, preferably when there is a good stern trim. Water which was lying undetected at the fore end of the tank may have flowed to the after end, or the tank may have been partly refilled by mistake.

Often a draft surveyor will accept well presented records of this sort, so that the true ballast tonnage—measured accurately when there was a substantial stern trim-is used instead of the less accurate tonnage obtained from soundings taken when the vessel is near even keel.

Ballast residues: Typical ballast residues for well run ships in the laden condition, as measured by accurate surveys, are approximately: mini-bulkers, 20 tonnes; handy-sized bulkers, 50t; Panamax-sized bulkers, lOOt; and Cape-sized bulkers, 200t.

Maintenance of ballast compartments

Requirement for maintenance: The maintenance required for ballast compartments includes the removal of sediment (mud), the removal of scale, the repair of leaks and the renewal of coatings.

Any time that mud-laden ballast is loaded into ballast tanks and held there for longer than a few hours, mud will be deposited on horizontal and near horizontal surfaces within the tank. A ship which regularly discharges and takes ballast in mud-laden rivers such as the Maas or the Mississippi will quickly accumulate heavy deposits of mud. It is not unusual for such mud to built up over a period to a depth of 10 cm. It has been calculated that mud accumulated to an average depth of 7.5 cm in the ballast tanks of a 3,000-tonnes deadweight mini-bulker weighed about 50 tonnes. The weight of mud in a Cape-sized vessel with deposits of a similar depth would be considerable.

Mud accumulated within a ballast tank reduces the ship's cargo lifting capacity, makes inspection of the tank for damage and condition of coatings much more difficult, and makes draining of ballast from the tank a slower and more inefficient process. These are all good reasons for removing mud from ballast tanks and for preventing the build-up of mud as far as possible.

Entering ballast tanks: Entering any enclosed space can be dangerous and the procedures recommended by the International Maritime Organization should be followed when entering a ballast tank. (This matter is discussed in greater detail in Chapter 21.)

Immediately after a tank has been deballasted it is reasonable to expect the air within the tank to be as healthy as the air on deck, since all the air in the tank will have been drawn from on deck whilst the tank was being deballasted.

Removal of mud by shovel and bucket: There are several alternative methods of removing mud. The most labour-intensive option is to remove mud by bucket and shovel. This is only a practical option when plenty of time and large quantities of cheap labour are available, as might be the situation in drydock or in layup. It may be worthwhile to remove mud from positions close to the ballast suction by shovel and bucket, but other alternatives will normally be found less expensive for a ship which is in service.

Hosing of topside and forepeak tanks: In

compartments in which it is comparatively easy to move about, such as forepeak and topside tanks, the mud can be hosed towards the ballast suction and pumped out. Since these tanks can normally be entered at any time except when water is being shipped on deck this work can be undertaken at almost any time that the tanks are empty and the discharge of ballast is permitted. However, the hosing of mud from topside and forepeak tanks remains a slow and labour-intensive job because of the time required to wash all the mud to the vicinity of the suction, and the possibility of problems in keeping the pump running when the supply of water to the suction is small and uncertain.

Hosing of double-bottom tanks: The limited height and confined space within the double-bottom tanks of all but the largest ships make the hosing out of mud from these spaces, using a washdeck hose., not normally a practical proposition. However, the hosing out of the double-bottom tanks of a Panamax bunker was undertaken in drydock to remove 600 tonnes of mud. In this instance a number of holes were cut in the ship's bottom so that the mud could be hosed into the dock bottom, thereby reducing the distance the mud had to be hosed through the tanks and avoiding shipboard pumping problems.

Since double-bottom tanks of handy-sized and mini-bulkers are normally entered from the holds, it is only possible to enter these tanks when some at least of the holds are empty. This will occur in port, at anchor, during ballast passages or whilst part cargoes are being carried. The double-bottom tanks of Panamax and Cape-sized bulkers can normally be entered from the stool spaces, permitting access at any time that the tanks are empty.

High-pressure hosing of double-bottom tanks: The hosing out of a very cramped double-bottom tank in a mini-bulker has been achieved using a portable high-pressure washing machine, connected to a long lightweight hose no larger or heavier than the cable used with oxy-acetylene welding equipment. The work was illuminated by a gastight torch lashed to the probe of the high pressure hose. Washing was commenced at the after end of the tank, nearest to the suction, so that drain holes were cleared, permitting the liquid mud created by the washing to flow aft to the ballast suction. It was found that the water jet sliced up the 8 cm thick, claylike mud very effectively, and reduced it to a runny porridge in about 6 mins/sq. metre. This work is physically demanding and suitable only for active persons.

Use of sediment remover: Sediment removers are liquid compounds which hold mud in suspension, preventing it from settling on the tank surfaces and permitting it to be discharged with the ballast in which it was loaded. They remain efficient indefinitely. Since any chemical additive is expensive it is important to obtain the best value for money spent. To ensure that best value is obtained there are a number of practical considerations to take into account.

The most beneficial time to use a sediment remover is when the following conditions can be met:

- A double bottom ballast tank is heavily coated with mud.
- The passage can be made with the ballast tank 25% full.
- A swell is anticipated, to make the ship pitch and roll.
- The ship can be brought to even keel.
- The tank can be emptied after a period of rough weather.

It is seldom that a passage can be undertaken with a part-filled double-bottom ballast tank, since longitudinal stresses or loaded draft often prevent it. Nevertheless opportunities do arise—for example, when the ship is carrying a full low density cargo such as coke or coal, and is not loaded to her marks, or when she is loaded to winter marks, but passing through a summer or tropical zone. In addition, stress calculations may show that certain double-bottom tanks can be left empty, or part filled during a ballast voyage.

One reason for wanting the tank only 25 per cent full is that this will permit the maximum agitation of the water over the deposited mud as the ship pitches and rolls, thereby taking the greatest quantity of mud into suspension. In addition, the quantity of sediment remover to be used depends upon the quantity of ballast in the tank. A tank which is only a quarter full can be treated more efficiently, and much more cheaply, than a full tank. A tank which is half full is more liable to suffer damage from sloshing.

The scouring effect of the water in the tank, induced by the ship's motion, will be most effective when the water is surging in the same direction as the framing in the tank. Where longitudinal framing is fitted, a pitching motion will be more effective in raising the sediment than will rolling.

For best results it is important that the ship be exactly even keel when under way after the tank has been filled to the required level. It must be remembered that bulk carriers usually trim by the head when under way and allowance should be made for this. If the ship is not even keel whilst the sediment removal is taking place, it will be found that one end of the tank will be cleaned whilst the other end, which the water has hardly reached, remains thick with mud.

Every effort should be made to ensure that the sediment remover is thoroughly mixed with the ballast water in the tank. This is normally achieved by pouring it little by little into the tank by way of a sounding or air pipe adjacent to the ballast suction whilst the tank is filling.

Inspection of the tank before and after treatment is strongly recommended, to assess the results achieved and to gather information on how the process can be improved. The manufacturers of one product in this field, Rochem sediment remover, state that their product is polymer based, contains no acid, alkali or solvent, is completely biodegradable and has no flashpoint.

Removal of scale from ballast tanks: If the coatings in ballast tanks are allowed to deteriorate, either generally as a result of old age or locally as a consequence of mechanical damage, loose scale will be deposited and will tend to accumulate around drainage holes and near the ballast suction. Deterioration of tank coatings is aggravated by mechanical damage. The tanks which are most at risk depend upon the size of ship and the trades in which she is engaged. The topside tanks of mini-bulkers generally suffer most from grab damage and contact damage whilst berthing, whilst Cape-sized vessels sustain most of their damage in the tanktop which tops the double-bottoms. The loose scale will tend to reduce or prevent the flow of water to the ballast suction and should be removed. The only practical way of removing loose scale is with shovel and bucket, to be passed to the deck when filled. Provided that this process is done regularly the quantities to be removed will not be too great.

Patching of leaks in ballast tanks: It is quite common for small leaks to develop in the steel plating which forms the boundary between the holds and the topside tanks. In smaller bulk carriers such leaks are often the result of berthing impact on the vessel's port shoulder. They occur primarily on the port side of the vessel in the vicinity of the forward hold and appear to result from the transmission of the impact load through the transverse internal members of the topside tank.

Whatever their cause, small leaks in topside tanks interfere with the efficient operation of the vessel. If the leaking tank is filled a spray of water spurts into the hold and a dry hold cannot be presented for loading. The leak may be sufficient to induce gradually a list into the vessel over a period of one or two days, which is inconvenient. Alternatively, if the affected pair of topside tanks are left empty, the forward draft may be unacceptably small, requiring the ship to slow down or causing her to pound. In larger vessels the longitudinal stresses may be excessive, making it unsafe to leave the tank unballasted.

The appropriate response to leaks of this sort is a professional repair undertaken by a qualified welder, but readers may be interested in the details of a method of quick temporary repair for small cracks and pinhole leaks. The method involves the use of patches of heated Ram-nek high adhesive plastic tape. The equipment required is a scraper, a blowtorch, a length of Ram-nek tape and shears or a knife to cut the tape.

Within the tank the surroundings of the leak are scraped clear of loose paint and scale and a Ram-nek patch, measuring about 15 x 15 cm, is centred over it, perhaps being held in position with the scraper. A second Ram-nek patch, similar in dimensions to the first, is placed conveniently to hand. The patch which has been placed over the leak is heated to a molten, bubbling state with the blow torch and the second patch is then pressed firmly into place over the first. Provided that this is done quickly the patch can be pressed into place before the heat passes through it, making it too hot to touch with comfort. This forms a robust, flexible patch which seals the leak until a permanent repair can be made and which, unlike a poor run of weld, will not fracture again. Proper full repairs should, of course, be undertaken as soon as possible.

Maintenance of coatings: All the steelwork within the ballast tanks will have been coated when the ship was built and the coatings should be maintained in good condition throughout the life of the ship, to prevent excessive corrosion of the steelwork forming the tanks. Ships' personnel cannot hope to renew the coatings of ballast tanks without very specific support and assistance in the form of labour and materials from the ship operators since the job is a big one.

However, coatings within ballast tanks will deteriorate as a result of local mechanical damage caused by contacts with fenders, jetties and tugs, and damage caused by cargo, grabs and mechanical shovels. Damage of this sort can be made good without great effort and any opportunity should be taken to clean, prime and repaint any damaged areas, using the same paint system as was used previously.

As an example of what can be achieved by a well organised ship's crew, the case of a 16-month-old Cape-sized (115,000 tonnes dwt) bulker on a laden passage from Hampton Roads to Pohang, Korea, can be quoted. The vessel had sustained approximately 15 per cent breakdown of tank coatings, mainly below the double-bottom tanktop and lower hopper sides. All mechanical damage in all double-bottom and topside tanks was scraped clear of rust and flaking paint, wiped clean, coated with rust inhibitor, primed and painted with a recommended tank coating. The entire operation took 39 days and involved six men working eight hours/day, a total of 1,872 man/hours.

Inspections of ballast tanks: All of a ship's ballast tanks should be inspected regularly, say, twice yearly, by competent ship's personnel, mindful of all the points which have been mentioned in this chapter. Matters to be noted and recorded are the condition of internal fittings such as ballast suctions, sounding pipes, airpipes and other pipework passing through the tank, quantities and locations of scale and sediment, condition of tank coatings and percentage breakdown of coating, and details of any structural damage observed. The findings of ballast tank inspections should be recorded, and copies should be sent to the shipowners.

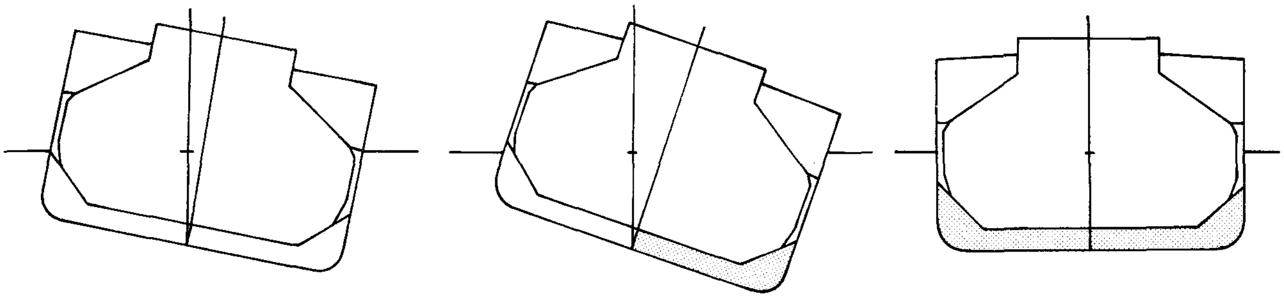
Closing of ballast tanks: On completion of work in, or inspection of, ballast tanks care must be taken to ensure that they are properly closed with watertight seals to ensure that water cannot subsequently leak out of, or into, the tank. Correct sealing of manhole covers will be achieved by the use of a gasket which is in good condition and by ensuring that the gasket and the steel surfaces of manhole and manhole lid are absolutely clean, smooth and free of particles of scale or cargo. Once closed and sealed, the watertightness of the ballast tank should be tested by filling it and inspecting the closed manholes for signs of leakage. (This procedure is described in greater detail in Chapter 5.)

Sources

28. Buxton, I. L. and Logan, J. A. 'The Ballast Performance of Ships with Particular Reference to Bulk Carriers'. RINA. 1986
33. Caro, J. P., and Spink, H. E. 'Hong Kong Administration's View of Bulk Carrier Casualties & Losses'. Intercargo/IBJ Seminar. 1991.
34. IMO Bulk Cargo Committee Document BC 30/17/Add.l Annex 3, P.54
35. Logan, J. A., and Chreseson, P. J. 'The Application of Controllable Ballasting to Cargo Carrying Ships'. NECIES. 1986.
51. Rigby, Dr. G., & Hallegraeff, Dr. G. Ballast Water Exchange Trials and Marine Plankton Distribution on the mv *'Iron Whyalla'*. BHP Research. 1992

CHECKLIST - Reminders regarding ballast operations

- ☐ Calculate longitudinal stresses and do not exceed limits.
- ☐ Calculate stability and ensure it is always sufficient.
- ☐ Maintain sufficient draft forward, at sea.
- ☐ Avoid part-filled ballast holds and topside tanks.
- ☐ Choose light or heavy-weather ballast, according to conditions.
- ☐ Increase or reduce ballast if weather conditions change.
- ☐ Plan every stage of discharge/ballast or load/deballast programme before operations commence.
- ☐ Keep strictly to programme for discharge/ballast and load/deballast.
- ☐ Inspect holds, decks and overside for possibility of ballast overflow damage before commencement of ballasting, or dumping topside tanks.
- ☐ Do not overpressurise tanks. Ensure airpipes are not blocked. Do not use two pumps on one small tank.
- ☐ Always maintain trim by the stern while deballasting.
- ☐ Reduce pumping rate, and then stop filling of ballast tanks before they can overflow.
- ☐ Lower/close airpipe cowls, if design requires it, when tanks are full.
- ☐ Check ballast soundings daily during voyage to detect problems.
- ☐ Change ballast at sea when bound for Australia, New Zealand, North American Great Lakes or freezing destinations.
- ☐ Where necessary empty and clean ballast hold at sea and then refill, when a particularly clean hold will be required for the next cargo.
- ☐ When changing ballast at sea do not exceed longitudinal stress limits, and empty port and starboard tanks together, to avoid twisting the ship.
- ☐ Raise/open airpipe cowls, if design requires it, before emptying tanks.
- ☐ Commence deballasting before arrival in loading berth provided that circumstances are favourable.
- ☐ Use trim and list to help drain ballast tanks.
- ☐ Immediately on completion of deballasting the topside tanks ensure all dump valves are shut before draft is too deep and tanks start to flood. Log the closing of the dump valves.
- ☐ Keep detailed and accurate records of ballasting/deballasting.
- ☐ Take safety precautions when entering ballast tanks.
- ☐ Maintain ballast tanks in good condition by preventing and removing sediment and scale, touching up paintwork in way of damage, and patching/repairing leaks.
- ☐ Inspect tanks twice yearly, and record conditions found.
- ☐ Close tanks properly and verify that doors are watertight.



1 VESSEL LISTED TO AN ANGLE OF LOLL

2 DB TANK ON LOW SIDE IS BALLASTED. ANGLE OF LOLL INCREASES.

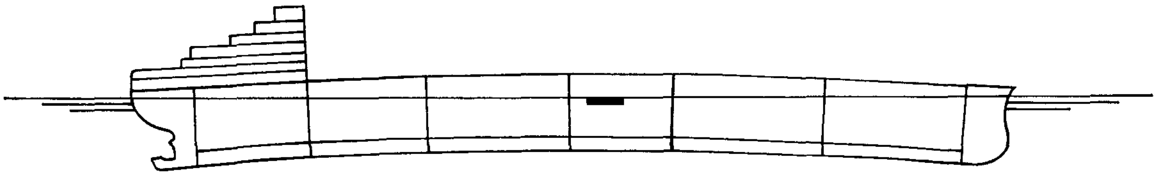
3 DB TANK ON HIGH SIDE IS BALLASTED. VESSEL RETURNS TO UPRIGHT, WITH POSITIVE STABILITY RESTORED.

BALLASTING TO REMOVE A LOLL

FIG 8.2

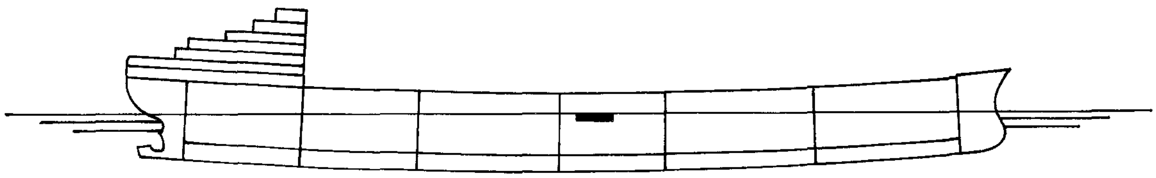
VESSEL HOGGED

MOST OF THE WEIGHT OF CARGO IS, OR HAS BEEN, PLACED AT THE ENDS OF THE VESSEL



VESSEL SAGGED

MOST OF THE WEIGHT OF CARGO IS OR HAS BEEN PLACED IN THE MIDDLE OF THE VESSEL.
THIS IS A MORE USUAL LOADING



THE HOGGED VESSEL, WHEN LOADED TO HER MARKS, WILL LIFT A GREATER TONNAGE BECAUSE SHE DISPLACES MORE WATER AT THE FORWARD AND AFTER ENDS.

FIG 8.3

Chapter 8

STRENGTH, STABILITY, DRAFT AND TRIM

Shear forces and bending moments, ship movement in a seaway, springing, hull stress monitoring, stability, free surface effect, angle of loll, flooding, sloshing, hogging and sagging, squat, effects of list and heel, change of trim due to change of density

THIS CHAPTER contains reminders of the strength, stability, draft and trim considerations which must be taken into account when operating a bulk carrier if damage is to be avoided and operations are to be efficient. It is not intended as a primer in ship construction and stability, subjects which can only be adequately studied from books devoted to the subject. Such books are available and some are listed in the sources at the end of this chapter. Possible causes of bulker casualties are discussed in Chapter 26.

Shear forces and bending moments

All bulk carriers which are Panamax sized or larger, and all which are strengthened for loading in alternative holds, are provided by their classification societies with maximum allowable still water values for shear forces and bending moments. These values are stated in the ship's loading guidance and stability information booklet and are included in the program of the ship's loading instrument, if she has one. These values, which are provided to ensure that the ship is not damaged by incorrect loading, must be calculated for every stage of a loading or discharge and of a voyage, and must never be exceeded.

Normally two or three sets of maximum values will be stated. The in-port values for shear forces and bending moments are the maxima to which a vessel can be subjected whilst in the 'still' (i.e., sheltered) waters of a port, where she is not exposed to swell conditions. It is permissible to incur a higher level of stress, (up to the in-port limits), during stages in the loading or discharging provided that the stresses are reduced to lower at-sea levels before the vessel puts to sea. The in-port values are higher than the at-sea values because the latter take account of the additional stresses to which a ship is subjected when moving in a seaway.

A ship which is strengthened for heavy cargoes may be provided with two sets of maximum allowable values for bending moments in at-sea conditions, with one set being for 'Alternate Hold Loading Condition', and the second set for the 'Ballast or Uniform Hold Loading Condition'. The lowest bending moment values are allowed when alternate holds are loaded, since this is the condition in which the greatest stresses are created.

The shear forces and bending moments must be calculated before commencement of any of the following processes:

1. Planned loading and deballasting sequence.
2. Planned discharging and ballasting sequence.
3. Any change of ballast.
4. Any change in loading or discharging sequence.
5. Any instance when deballasting is delayed and becomes out of sequence with loading.
6. Any instance when ballasting is delayed and becomes out of sequence with discharging.
7. Taking of bunkers, step by step (i.e., tank by tank).
8. Consumption of bunkers, step by step (i.e., tank by tank).
9. Docking.

If the allowable values are exceeded there is danger that the ship's structure will be permanently damaged—it is even possible for the ship to break into two. The importance of completing the calculations and ensuring that the stresses are not exceeded cannot be stated too strongly. The most likely reasons for failure to comply with this requirement are the underlisted; they must be avoided.

- Failure to understand the calculations.
- Data provided in language which is not understood.
- Computer breakdown.
- Inability to make the manual calculations when the computer has broken down.
- Stability data unreadable.
- Change in loading/discharging programme.
- Failure to follow loading/discharging programme.
- Pressure of work.
- Negligent practices.
- Commercial pressure.
- Routine procedure undertaken without planning.

Small vessels up to and including handy size may be provided with no maximum allowable values or programs for calculating shear forces and bending moments. This is because the short length and comparatively greater scantlings of a small vessel make it impossible to expose her to excessive values of shear force and bending moment unless she is jump loaded (loaded in alternate holds).

Ship movement in a seaway

Ships are designed to withstand the weather conditions which are to be expected at sea, provided that they are handled carefully. When heading into adverse weather damage is likely to be suffered if the ship is allowed to pound with the forefoot crashing down upon the sea surface, or to slam with the bows plunging into the swell. Shipping green seas over the bows in adverse weather should be avoided. It is likely to cause damage to deck fittings and hatch covers as a consequence of the weight of the water shipped and the violence of its impact, particularly in ships without raised forecastles.

A ship beam-on to a steep swell may roll very heavily. Such an attitude may occur as a result of the course being steered or as a result of an engine failure. In addition a ship which has had the weather astern may be caught in the trough of the swell if an attempt is made to turn into the wind in order to heave-to. Such heavy rolling may lead directly to damage to a vessel's hull and superstructure, and may also cause the shifting of cargo which can also damage the ship or reduce her positive stability.

One result of rolling is that the side shell plating is repeatedly plunged into the sea and then removed. This results in repeated variations in the water pressure applied to the side shell. This panting effect may have a long-term weakening effect upon the side shell plating, and the structure to which it is attached. (The conduct of ships in heavy weather is described in Chapters 15 [loaded vessels] and 17 [vessels in ballast].)

Springing

Seafarers report[52] having occasionally experienced abnormal springing of the hull of their ships. This effect has also been named flexing, whipping and wave excited hull vibration. It may be visible as a succession of waves, flowing along the steelwork of the main deck of the vessel, associated with heavy vibration, or shuddering, of the structure of the ship. This phenomenon is sometimes the result of propeller damage or the isolating of one main engine unit.

Alternatively, it may be a dynamic response induced by waves or swell when the ship is loaded in a particular way. In this case it is usually possible to stop the flexing by an alteration of course. When course cannot be altered, a change of speed or a ballast change may stop the motion. Such violent working of the ship's hull is likely to damage it and every effort should be made to avoid it.

Hull stress monitoring

A few large bulk carriers have in recent years (early 1990s) been equipped with hull stress monitoring systems which measure longitudinal and slamming stresses.

Longitudinal bending stresses are measured by long base strain gauges situated at several selected points along the deck. This process is continuous at sea and in port, permitting stresses due to cargo operations and ballasting as well as the ship's movement in the seaway to be monitored.

Slamming stresses are measured by accelerometers usually placed so as to measure vertical accelerations in the fore part of the ship. High-pressure transducers, which detect the very high pressures experienced with slamming, are placed in positions near to the accelerometers.

The readings from each of these instruments is relayed to a desktop computer, usually placed on the bridge, where it provides the master and watch officer with a visual indication of the stresses induced in the hull. If required, the data can be retained on a hard copy print-out or disc.

Stability

A stable ship is one which will return to the initial position when inclined by an external force. An unstable ship is one which tends to heel still further when inclined to a small angle. One of the objectives of the ship's master and officers is to ensure that their ship remains stable throughout her life and cannot capsize.

An approximate indication of the ship's stability can be obtained from the metacentric height (the GM), which can be readily calculated provided that the positions of all weights in the ship are known with reasonable accuracy. The GM must be corrected for free surface effect, described below, to obtain the fluid GM.

When the fluid GM is large the ship will be very stable, or 'stiff. A stiff ship is uncomfortable in a seaway. She rolls violently and rapidly. Unfortunately, this condition is common aboard bulk carriers when they carry high density cargoes such as heavy ores and steel. A ship with a small fluid GM is less stable. She can be inclined more eaily, and will roll more slowly. This condition, known as 'tender', is common when low density cargoes such as coal and coke are carried.

The ideal stability condition for a ship lies somewhere between stiff and tender. Aboard a bulk carrier the ship's stiffness will be governed primarily by the design of the ship and the nature of the cargo carried. A ship is prohibited from undertaking a voyage in too tender a condition—she must satisfy the minimum stability criteria at all stages in the voyage—but there are no rules which forbid a ship from sailing in a very stiff condition, and bulkers are often required to do so.

Before a ship is permitted to go to sea she must comply with the requirements of the International Loadline Convention which call, amongst other things, for a more extensive assessment of her stability than is provided by the calculation of fluid GM alone. The ship's loading guidance and stability manual will provide details of the calculations required, which are also fully discussed in *Bulk Carrier Practice* Chapter 10. The stability manual also states the minimum permitted values for areas under the statical stability curve for the righting lever and for the fluid GM.

The rules which require the calculation of a vessel's stability before she puts to sea are intended to ensure that no ship will go to sea in an unstable condition and subsequently capsize. They are in the best interests of every seafarer and deserve to be followed with care.,

If the calculations show that the ship has, or at some point in the intended voyage will have, insufficient stability, adjustments must be made. It may be possible to increase the positive stability by repositioning weight lower in the ship, by the addition of weight such as bunkers or ballast low in the ship, or by the removal of weight from high in the ship. Another option is the rearrangement of the contents of bunker and ballast tanks to reduce free surface effect. If all else fails it will be necessary to reduce the amount of cargo which can be accepted. (Planning of the loading is discussed in greater detail in Chapter 9.)

Free surface effect

When a tank in a ship is part filled with a liquid—normally ballast water, fresh water, fuel oil, diesel oil or lubricating oil—the liquid within the tank is able to 'slosh about' as the ship moves. This reduces the ship's positive stability by an amount which depends upon the dimensions of the tank, the density of the liquid and the displacement of the ship. Free surface effect must never be neglected; it can transform a stable ship into to one which will capsize.

In many tanks the surface area of the liquid changes with the quantity of liquid in the tank. As a consequence the value of the free surface effect also changes. Some stability tables quote only the maximum value of free surface moment for each tank. If this value is used, any error in the result will be a safe one. The ship will be as stable as the calculations show or she will be more stable than they show.

When making any stability calculations it must be assumed that any tank which is not full, or which is to be used later, has free surface effect. There may be times when free surface occurs, or is proposed, in a cargo hold as a result of hold washing or flooding. Loading manuals usually provide no method of calculating the effect of such free surface.

When considering sea water in a hold the free surface moments (FSM) can be calculated from the formula:

FSM = 1.025 x LEV 12 tonnes-metres, where

L = length of compartment, measured fore and aft, in metres and

B = breadth of compartment, measured athwartships, in metres.

The virtual rise of centre of gravity, in metres (GiGo) = FSM/Displacement(tonnes).

A worked example of this calculation is provided in Appendix 8.1.

Angle of loll

Ships which become slightly unstable will list to an angle of loll. This condition can often be recognised by the fact that the ship will 'flop over', which is to say that she will list quite noticeably first to starboard and then to port (or vice versa) dependent upon such factors as the direction from which the wind is blowing, and the way the vessel heeled when the last alteration of course was made. If derricks or cranes are topped up when a ship is resting at an angle of loll that angle will increase.

A loll has in the past often been associated with ships carrying lumber or woodpulp on deck. If the stability calculations have been inaccurate it is possible for such ships to complete their voyage with no positive stability and to commence to loll as more bunkers are consumed and negative stability develops. However, there are often other possible explanations for any list which such a ship develops towards the end of the voyage. The list may be due to the quantity of water which has been absorbed by the deck cargo on one side of the ship, perhaps because that was the weather side for most of the passage. Alternatively, the list may simply be due to an inbalance between the weights of bunkers and cargo to port and starboard of the centre line. In these cases, of course, the ship will remain listed to one side and will not flop from side to side.

The occurrence of loll must always be taken very seriously, since it shows that the ship has become unstable, and the reason for it must be sought with care. On one notorious occasion the master and crew of a dry-cargo vessel which developed a large list were so convinced that the list was caused by the large tonnage of cargo on deck that they completely overlooked 400 tonnes of water which had flooded one of their holds!

If a ship is found to be at an angle of loll the following steps should be taken to improve her stability.

- Slack tanks should be filled where possible to eliminate free surface effect.
- Weights should be lowered in the ship where possible, for example for transferring bunkers from deep tanks to double bottom tanks.
- If empty double-bottom (DB) tanks are available the stability can be improved by filling them with water ballast or with fuel oil, as appropriate and as available. When filling such tanks there are two important rules to remember: pairs of small DB tanks should be filled before pairs of large DB tanks; and in each case the tank on the low side must be filled before the tank on the high side.

For example, if the vessel has taken up an angle of loll to starboard (Fig. 8.2) the starboard double-bottom tank must be filled before the port one. This will initially result in a further increase in the angle of loll to starboard, but the increase will be gradual, and well controlled. Thereafter, when the opposite double-bottom tank is filling, the angle of loll will diminish and eventually disappear, provided that the filling of the first pair of double-bottom tanks is sufficient to eliminate the negative stability.

If these rules are ignored, and the double-bottom tank on the high side is mistakenly filled first the ship will, at some time during the process, roll over violently from her angle of loll to starboard to take up a similar angle of loll to port. The object of filling pairs of small tanks before pairs of large tanks is to ensure that the temporary increase in list is kept to a minimum.

Flooding

Accidental flooding of a compartment will almost invariably cause an unexpected list to develop. Flooding is also often associated with sudden increases or reversals of list, and any of these effects should ring warning bells in the mind of the duty officer and prompt him to make an urgent search for an explanation.

When an empty compartment such as a cargo hold is flooded the free surface effect will be the maximum for that compartment. If the compartment contains cargo the free surface effect will be reduced until such time as the water surface rises above the level of the cargo.

Sea water which enters a hold may do so by a number of alternative routes. Water may enter direct through holes in the ship's side or deck, it may pass through leaky hatch covers or through ventilators which are damaged or inadequately closed. Ballast water may leak from ballast tanks, and water may pass into the hold through eductor systems or bilge lines with faulty valves or as a result of faulty procedures.

The flooding of one hold of a bulk carrier which is loaded with a low density cargo such as coal is unlikely to cause such a vessel to capsize. Since the hold will be filled with the cargo the loss of buoyancy and the increase in free surface effect will not be excessive. If the bulker is loaded with a high density cargo, the level of flood water is more likely to rise above the surface of some or all of the cargo and the free surface effect will be larger. However, a ship carrying a high density cargo will have a much larger initial GM so this

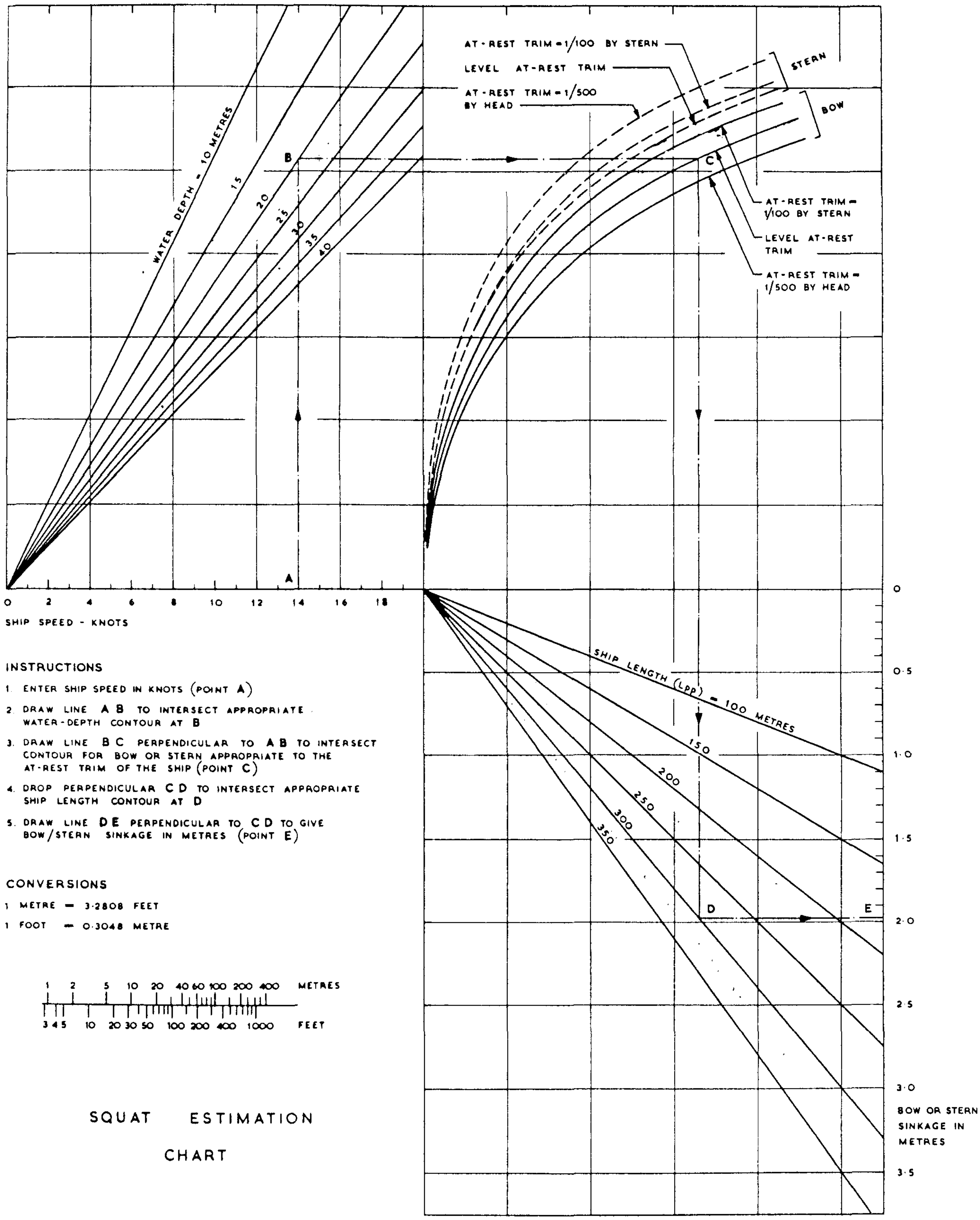


Fig 8.4 *[Courtesy Dr Ian Dand]*

vessel, too, is unlikely to capsize as a result of the flooding of a single hold.

Sloshing

A bulk carrier which experiences flooding is more likely to suffer structural damage from sloshing than to capsize. Sloshing is the violent movement of liquid within a compartment as a result of the ship's motion in a seaway. If the natural frequency of sloshing approaches that of the ship motion frequency then resonance will occur, large wave amplitudes and pressures will be set up in the tank, and damage can occur[27]. If a ship suffers flooding there is a danger that sloshing of the flood water will cause the collapse of watertight bulkheads, permitting the flooding to spread to adjacent holds.

Sloshing effects are likely to be most violent when a compartment is half full; a compartment which is almost full or almost empty is less at risk. This is recognised in the restriction sometimes imposed by classification societies upon the filling of ballast holds. Such a restriction is likely to be that the ship must not operate with the ballast hold filled to a level which lies within the 20-70 per cent range of full capacity.

Sloshing within ballast tanks is likely to be less of a problem than sloshing within holds, as the internal structure of the ballast tanks has a substantial damping effect. Nevertheless, pardy filled ballast tanks should be avoided as far as possible in rough weather, unless a 'sloshing investigation' has been carried out by a classification society, and its approval has been given.

Hogging and sagging

A ship will experience hogging stresses when weight is concentrated at her forward and after ends. On a ship which is hogged the mean of the forward and after drafts will be greater than the mean draft amidships. (Fig. 8.3) When the weight carried by a ship is concentrated amidships that ship will experience sagging stresses. The mean midships draft will be greater than the mean of the forward and after drafts when a ship is sagged.

Any ship which loads to her marks must load to the midships draft specified in her international leadline certificate. If such a vessel is hogged her forward and after drafts will be deeper than will the drafts of the same vessel, if sagged. Thus a vessel when hogged can legally lift a greater deadweight than the same vessel if sagged. This fact has been known for very many years and is said to have caused masters in the past to 'bend' their ships with successive cargoes to make them permanently hogged, and thereby to increase the tonnage of cargo they could carry. This can never have been a prudent action to take, but may have been tolerable when ships were smaller and ships' structures were built with larger safety margins than is the case today.

Nowadays, with the assistance of calculations to find the values of shear force and bending moment, it will be found that when stress values are minimised the vessel will be sagged. This is the natural consequence of the fact that the cargo spaces are located along the middle body of the ship; cargo cannot be loaded in the machinery and storage spaces which occupy the bows and stern. The result of this is that a vessel which is loaded to minimise stresses will fail to lift the 'full' deadweight cargo which corresponds to a level trim, and which the charterer expects.

If an attempt is made to improve the tonnage of cargo lifted by introducing a hog, or even by eliminating the sag, it will be found that stresses increase, with highest values of shear stresses occurring immediately forward of the bridge and at the forepeak bulkhead. Provided that the shear forces remain within the maximum allowable limits this condition is not forbidden, but ship operators must consider whether it is advisable to load a ship, time after time, to stress values which are higher than normal and close to the maximum permitted, as is the case when bulkers are loaded in alternate holds.

Squat

When a ship is under way she pushes her way through the water. The water which is pushed away will travel down the sides and under the keel of the ship. This moving water causes a drop in pressure beneath the hull and the ship is drawn vertically down in the water. The ship will also trim until equilibrium is obtained. Squat is the mean increase in draft—i.e., the sinkage—plus any contribution due to trim, and is usually measured forward or aft, whichever is greater.[29]

Bulk carriers are full bodied ships with block coefficients of 0.8 upwards. Ships with a block coefficient greater than 0.7 can be expected to trim by the head as a consequence of squat. Thus a bulk carrier which is trimmed to even keel on completion of loading will trim a little by the head when under way. Similarly the stern trim of a vessel trimmed by the stern when at rest will be reduced by squat when she is under way.

The amount of squat experienced increases considerably in shallow water and also where the width of water available is limited. Since bulk carriers are often required to visit ports where underkeel clearances are small, a good knowledge of the values of squat to be expected is essential.

Squat in narrow and shallow waters is greatest at high speed and is zero when the ship is at rest in the water. Squat varies approximately as the square of the vessel's speed through the water, so the value of squat can be quickly reduced by reducing speed when required to avoid grounding.

When water depth is restricted approximate values for squat for bulk carriers can be obtained from the NMI Squat Chart (Fig. 8.4). Typical values for standard bulk carriers trimmed to even keel when stationary are quoted hereunder. These assume a depth of water equal to draft +10 per cent, and a speed made good of 10 knots, both of which are extreme conditions for normal operations in shallow water. The actual values of squat which occur during normal operations in port will usually be less, because the ship's speed will be less and/or the depth of water below the keel will be greater.

Class of Bulker	Length BP (m)	Draft (m)	**Water Depth (m)**	**Squat (m) Aft**	**For'd**
Mini	99	6.8	7.5	0.7	1.0
Handy-sized	183	10.2	11.2	0.8	1.1
Panamax	224	14.0	15.5	0.6	0.8
Cape-sized	292	17.3	19.0	0.6	0.8
VLBC	315	20.0	22.0	0.5	0.8

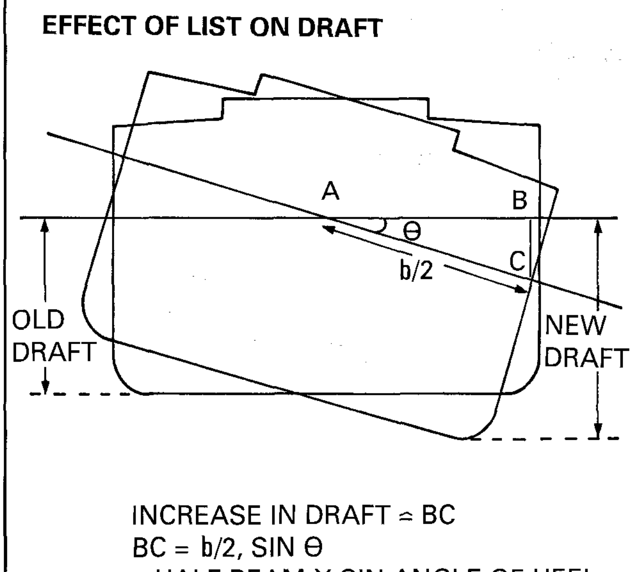


FIG 8.5

Effect of list or heel upon draft

When a vessel is listed by an uneven distribution of weights or when she is heeled by an external force, her draft will be increased beneath the low side of the deck. A useful approximation of the increase in draft can be obtained from the ship's geometry (Fig. 8.5), and examples are quoted below which serve to draw attention to the substantial increases in a ship's draft which result from a list or heel. If a precise measure of the increase in draft is required it will be necessary to take account of the change in the waterplane area when the vessel heels and of the measurement of the hull in way of the turn of the bilge.

Class of Bulker	**Beam** (m)	**Draft Increase** (m) **for list** Ideg	3deg	5deg
Mini	16.4	0.14	0.43	0.72
Handy-sized	23.0	0.20	0.60	1.00
Panamax	32.2	0.28	0.84	1.40
Cape-sized	43.8	0.38	1.14	1.91
ULBC	47.0	0.41	1.23	2.05

Change of trim when passing from salt water to fresh water

When a ship passes from water of one density to water of another density her mean draft is changed, and if the longitudinal position of the centre of buoyancy changes the ship's trim will change. As the draft changes, the longitudinal position of the centre of buoyancy *will* change if the bows and stern of a ship are different shapes, as is usually the case.

Draft and trim are usually of most concern when the vessel is laden, and operating at her deepest draft. Deep-laden vessels are usually trimmed even keel, or nearly so. A useful illustration of the importance of the matter is provided by a particular Panamax-sized vessel requiring to pass through the Panama Canal at maximum draft (i.e., 39ft Gin = 12.04 metres).

She must be on the maximum permitted draft and even keel when transiting the main section of the Canal where density is 995 kg/m^3. Her increase in draft when passing from density 1025 kg/m^3 to density 995 kg/m^3 is 36 cm, and change of trim can be calculated to be 12 cm by the head, an amount which cannot be ignored. To achieve 12.04 metres even keel in the canal (when in water with density 0.995 kg/m^3) it can be calculated that the vessel must be floating at 11.62 m forward, 11.74 m aft in salt water, with a trim 12 cm by the stern, before commencing the Canal transit.

Formula for change of trim with change of density: The formula for trim change when passing from water of one density to that of another is:

Change of trim (cm) = Displacement x Shift of CB/MCTC, where:

Displacement = Displacement in tonnes, at initial draft.

MCTC = Moment to change trim 1 cm, in tonnes-metres, at initial draft.

Shift of CB = Shift in position of Longitudinal Centre of Buoyancy = (LCBi - LCB_2), where LCBi is distance of LCB from midlength, in metres, at initial draft, and LCB2 is distance of LCB from midlength, in metres, at final draft.

If the position of the CB moves aft, the change of trim is by the head. A worked example of the calculation is contained in Appendix 8.6.

Stability of ships carrying grain and forest products

Both grain and forest products provide particular stability problems. (Their carriage is discussed in Chapter 19, and the associated calculations are to be found in Chapter 10).

Sources

27. Buxton, I. L., & Logan, J. A., The Ballast Perform ance of Ships with Particular Reference to Bulk Carriers'. *Trans. RINA,* 1987.

29. Muckle, W., *Naval Architecture.* Butterworths. 1987.

48. Derrett, D. R., *Ship Stability for Masters and Mates.* Stanford Maritime Ltd. 1984.

52. Phillips, C., 'Ship Stresses when Carrying Coal'. *Seaways.* October 1991.

Chapter 9

PLANNING THE LOADING

Orders for loading, general approach, maximum lift, limiting point in voyage, factors which govern the distribution of cargo, the loading/deballasting programme, two berth and two port loading and discharge, block loading, two and multi-loader operations, the trimming pours, loading the optimum amount of cargo, the discharging programme, when cargo cannot be carried safety

Orders for loading

LOADING ORDERS may reach the master from the owners or direct from time charterers. To minimise misunderstandings orders should be written in plain English and should avoid the excessive use of abbreviations, particularly when the recipient is not a native English speaker. Despite this, the use of abbreviations will undoubtedly continue because of the resultant savings in costs of communications.

Loading orders should contain all the information which the master will require to enable him to plan the voyage and calculate the quantity of cargo to be carried. The information needed will depend upon the nature of the voyage; a complicated voyage involving several cargoes and ports will require more information than will a single consignment from one loading port to one discharge port.

Loading orders are likely to contain some or all of the following: loading port(s); discharging port(s); port rotation; loading dates; proposed cargo and its characteristics; proposed tonnages; tonnage limits; manner of segregation of different commodities; limiting drafts and air drafts; intended bunkering ports and quantities; intended routes and speed; and/or details of fuel and diesel oil consumptions proposed.

The master will normally be asked to confirm that he has received and understood the orders. To emphasise that the master must only accept the orders if he is satisfied that they are safe, he should also be asked to confirm that he has completed the necessary calculations and ensured that the vessel can safely comply with the orders. When the master receives the orders they must always be considered carefully. All questions which the orders contain must be answered, and any orders which are not clear and fully understood must be questioned. The master must satisfy himself that the orders can be safely executed.

The loading orders quoted below are for a Capesized bulk carrier. They contain a number of abbreviations, and explanations are provided for the less obvious of them:

REF NEXT VOYAGE - INTENTION LOADING FULL CARGO COAL HRDS/RICBAY FOR DISCHARGE KWANGYANG OR KWANGYANG AND POHANG. YR V/L WILL BE SUPPLIED WITH CAPACITY BUNKERS AT FLUSHING AFTER COMPLETION DISCHARGE REDCAR THEREAFTER WILL TOP OFF TO CAPACITY WITH BUNKERS AT HRDS. ROUTEING RICBAY - KOREA WILL BE VIA MALACCA STRAITS WITH POSSIBILITY ADDITIONAL BUNKERS UP TO MAX LOADABLE SUPPLIED AT SINGAPORE - WILL REVERT WITH CONFIRMATION SINGAPORE BUNKERING DURING VOYAGE ONCE PRICE DIFF FOR BUNKERS SINGAPORE/KOREA ESTABLISHED.

PLS ADVISE YR BUNKER REQTS FLUSHING.

CHARTERERS REQUEST YOU LOAD FOLLOWING . . .

AA ABT 60,000 LTONS CLINTWOOD GRADE COAL AT NORFOLK
BB ABT 40,000 LTONS PITTSTON GRADE COAL AT NNEWS
CC ABT 38,000 LTONS WITBANK GRADE COAL AT RICHARDS BAY

ASSUME SF 42 ALL GRADES.
HRDS/NNEWS HOLDS TO BE FILLED TO CAPACITY
ASSUME V/L PROCEEDS 46/47 MT PER DAY BALLAST/LADEN.

PLS ADVISE SOONEST PROVISIONAL HOLDWISE/GRADEWISE STOWPLAN.

In the foregoing, HRDS is Hampton Roads, the US East Coast port complex which includes both Norfolk and Newport News. RICBAY is the South African port of Richards Bay. The SF (Stowage Factor) of all the coal is given as 42 (cubic ft/ton), and the daily fuel consumption, in ballast and laden, is to be 46/47 tonnes.

The master is requested to provide, as soon as possible, his provisional stowage plan, showing the tonnage and trade to be allocated to each hold.

The master's reply to the orders is given below. It states the heavy oil and diesel oil bunkers required at Flushing, and indicates the tonnages and grades of cargo planned for each hold, and the total quantities to be loaded. Departure drafts for each loading port are given, with the departure from Richards Bay being planned to be even keel.

RYT NO.XXX NEXT VOYAGE REQ. 2650MT HO + 40MT DO AT FLUSHING.

PROPOSED STOWPLAN.

HOLD	MT	GRADE
1	12980	CLINTWOOD
2	16680	WITBANK
3	15440	PITTSTON
4	16420	CLINTWOOD
5	15460	PITTSTON
6	16420	CLINTWOOD
7	15650	PITTSTON
8	16670	WITBANK
9	14355	CLINTWOOD

CLINTWOOD	=	60175MT
PITTSTON	=	46550MT
WITBANK	=	33350MT
TOTAL	=	140075MT

EST DEP DRAFT HROADS F 14, 1M A 14, 3M
EST DEP DRAFT R'BAY 17.2M E/K

Another proposed loading for a Cape-sized bulker is given in the telex quoted below. This shows greater interest in the anticipated stresses, because the proposed cargo is iron ore, a high density cargo which will give rise to higher stresses and loadings than will coal. COB is 'close of business', and 10 PCT MOLOO means '10 per cent more or less, in owner's option'. This phrase is often used in charter-parties, and repeated in voyage orders. It allows the master the freedom to take the maximum tonnage of cargo his ship can safely and legally carry.

FOR POSSIBLE FUTURE TRADING PLS ADVISE SOONEST - LATEST COB LONDON 27/7 - IF YR V/L ABLE COMPLY GRADEWISE/STRESSWISE WITH FOLLOWING LOADING REQTS:

V/L LOADING TUBARAO 75,000 MTONS 10 PCT MOLOO IRON ORE THEN SHIFTING SEAWORTHY CONDITION TO SEPITIBA BAY WHERE V/L LOAD ADDITIONAL 75,000 MTONS 10 PCT MOLOO ORE. GRADES TO BE SEGREGATED HOLDWISE.

ASSUME V/L THEN PROCEEDS INDONESIA RANGE FOR DISCHARGE. BUNKER ROBS SUFFICIENT TO OTAKE DISPORT.

MAXIMUM ARRIVAL DRAFT TUBARAO 14.0M

MAXIMUM AIRDRAFT TUBARAO 16.5M

The ship's reply to the foregoing was as follows:

RYT 26/9 - POSS. FUTURE BIZ.

NO PROBLEMS ENCOUNTERED GRADEWISE OR STRESSWISE.

TUBARAO

	(MT)	
1	11000	
3	16500	DEP DRAFT 9.35F 12.40A
5	19000	
7	19000	
9	10370	
	75870	

SEPITIBA

2	18500	
4	13000	DEP DRAFT 17.40F 17.60A
6	15000	
8	21000	
	67500	

ARR. DRAFT INDONESIA RANGE 17.30F 17.50A

Some loadings are much more complex. Loading orders for a Panamax vessel, illustrating this point, are at Appendix 9.1.

General approach to planning

Whether planning the loading of a VLBC or a mini-bulker, the basic principles are the same. First, it is necessary to determine the maximum amount of cargo the ship can carry if restricted only by the leadline regulations. Then, the voyage must be studied, stage by stage, to identify any limiting point which will further restrict the amount of cargo which can be carried. Next, the disposition-i.e., the positioning-of the cargo in the ship must be decided and when this has been done a loading plan must be devised, to place the cargo safely in the required positions. Finally, the discharge programme must be planned to ensure that the cargo can be safely discharged.

To discuss this process we will consider first the simplest case: a ship loading a single bulk commodity in a single berth for a single discharge port. As an example an imaginary voyage of the *Regina Oldendorff* is taken, loading a full cargo of calcined phosphate rock in Fremantle for discharge in Avonmouth. The voyage is to be by way of the Suez Canal, with bunkers to be taken at Aden.

Maximum amount of cargo the ship can carry

On any particular voyage the amount of cargo that the ship can carry may be decided by her deadweight or by the volume of her cargo spaces. A high-density cargo such as ore will bring the ship down to her marks before the cargo spaces are filled. With low-density cargoes like grain, the opposite is true-the cargo spaces will be filled before the ship is down to her marks.

Cargoes such as coal are likely to be borderline cases, depending upon the grade of coal and the characteristics of the ship to determine whether she will be filled before the marks are reached, or vice versa. Where the slightest doubt exists, stowage factors (expressed as cubic metres to the tonne-m^3/mt; or cubic feet to the long ton-cf/lt) must be obtained and used to calculate the tonnage of cargo which the holds can contain.

In the example it is assumed that the calcined phosphate rock to be carried by the *Regina Oldendorff* is reported to have a stowage factor of 1.10 m^3/mt. This figure would normally be provided by the shippers via their agent, or by the operators, or obtained from the ship's own records of previous cargoes carried. The stowage factor (SF) will always be an approximate figure, since it is influenced by the shape of a ship's holds and the condition of the cargo upon loading, and these can vary from one ship and one parcel of cargo to another.

The total capacity of the cargo holds of the *Regina Oldendorff* (excluding the topside tanks, which can be used for grain) is 34,977.9 m^3. From this we can calculate that the ship can contain 34,977.9/1.10 = 31,798.1 tonnes of phosphate rock. This figure exceeds the maximum summer deadweight (28,031 mt), which demonstrates that this is a high-density cargo which will bring the ship down to her marks before the holds are filled. The maximum cargo which can be carried will depend, in this instance, upon the maximum acceptable draft and upon the maximum permissible load for each hold as stated by the vessel's classification society.

Besides the cargo the deadweight tonnage includes bunkers, stores and other items carried. These items have to be taken into account when the maximum cargo lift is calculated. The method of listing and labelling these items may vary from ship to ship; what is important is to ensure that all weights are listed, and that the tonnages carried are kept to a minimum.

In the case of the *Regina Oldendorffthe* weights to be carried will include sufficient bunkers to take her to the next bunkering port, plus a quantity in reserve. For the passage to Aden, the bunkering port chosen for this voyage, the ship will require at least 650 tonnes of fuel and 50 tonnes of diesel.

The following list contains typical figures for other weights. Weights on board:

Fuel	650 mt
Diesel	50
Fresh water	70
Crew & Stores	37
Ballast residues	50
Constant	120
Sag allowance	50
	1027 mt

(Strictly speaking, the sag allowance is not a weight carried, but a reduction in deadweight capacity which results from the ship's normal sag when loaded. It is prudent to include a sag allowance in all deadweight calculations, so that the charterer is aware from the beginning of the voyage of the cargo lift which can be realistically anticipated. The value used for sag allowance should be the average of capacity lost because of sag in previous voyages.)

Some of these values are likely to change during the course of the voyage as bunkers are consumed and replenished, and must be recalculated for any limiting condition. Because the maximum amount that the ship can carry depends, in this example, upon the vessel's draft one cannot in this case state the maximum amount of cargo that the ship can carry until the limiting draft for the voyage has been found.

Limiting point of the voyage

At various points in the voyage, limits may restrict the amount of cargo the vessel can carry. Such limits include the ship's maximum permitted draft at each stage in the voyage, dependent upon the geographical zone and the time of year, draft restrictions in the loading port, discharging port or some intermediate port such as a canal or waterway, and the requirement to carry changing quantities of fuel and water during the course of the voyage. It is necessary to consider all these limits and to identify which is the most restrictive.

In the imaginary voyage undertaken by the *Regina Oldendorff* from Fremantle, Western Australia, to Avonmouth, United Kingdom, in February, the limits which she will meet are the following:

Limits for the Voyage

Point in Voyage	*Limit*	*Maximum Draft(m)*
Load a full cargo	Summer marks	10.24
Departure Fremantle	Max for berth/port	12.65ek
Enter Tropical Zone	Summer marks	10.24
Arrive Aden	Max for berth/port	11.50ek
Depart Aden	Tropical marks	10.45
Suez Canal transit	Max for canal	16.20ek
Departure Port Said	Summer marks	10.24
Seasonal Winter Zone	Winter marks	* 10.03
Arrive Avonmouth	Max for berth/port	10.38ek

(ek = even keel) *limiting draft

The above limits fall into two categories. The limits imposed by the Leadline Rules are concerned with the ship's freeboard and draft amidships, but impose no restrictions upon her trim. The limits imposed by the depths and densities of water available in the ports and the canal, on the other hand, are absolute, and the maximum drafts can only be achieved if the vessel is even keel.

Another possible limit upon the amount of cargo to be carried must be mentioned-the tonnage to be carried may be stipulated in the charterparty. If the charterparty states that the *Owners undertake that the vessel shall load 25,000 tonnes of 1,000 kilos, 5 per cent more or less in their option,* then the tonnage to be loaded should not exceed 25,000 tonnes + 5 per cent, or 26,250 mt. This tonnage, carried with the bunkers and stores listed, would produce a deadweight of 27,277 mt, corresponding to a mean draft of 10.06 m as read from the deadweight scale, on departure Fremantle. For the purposes of the example we assume that the charterparty places no limit upon the tonnage of cargo to be carried.

At first sight it appears that the most exacting limit which the vessel will meet is the requirement to be on winter marks when entering the seasonal winter zone off Cape Torifiana, Spain. The object will be, therefore, to arrive off Cape Torihana precisely on winter marks, but to achieve this it will be necessary to carry and consume sufficient bunkers to reach this point, and calculations must be made back from the ship's condition at Cape Torifiana to earlier points in the voyage to ensure that no unacceptable drafts are required earlier in the voyage.

Before checking back to earlier stages in the voyage it is necessary to determine how much of the deadweight aboard at Cape Torinana will be cargo. The fuel and diesel totals will depend upon how much was taken at Aden and that, in turn, will depend upon the orders that the ship was given regarding bunkering. We have chosen to assume that the master was instructed to reach Avonmouth with sufficient fuel for three days' steaming, and that it was normal to keep fuel for two days in reserve. To arrive in Avonmouth with fuel for five days it would be necessary to pass Cape Torihana with fuel for seven days. The weights aboard upon passing Cape Torihana would be:

Fuel	273 mt
Diesel	25
Fresh water	70
Crew & Stores	37
Ballast residues	50
Constant	120
Sag allowance	50
Total weights:	625 mt
Winter deadweight	27,212
Cargo tonnage	26,587 mt

The next step is to ensure that this tonnage of cargo can be carried at earlier stages in the voyages, without exceeding the limits. An inspection of the table of limits for the voyage (above) suggests that the ship will have no difficulty in staying within the limits for the canal transit, for arrival Aden and for entering the tropical zone, provided that she complies with the maximum draft restrictions on departure from Fremantle and Aden, since her mean draft will reduce day by day at sea as bunkers are consumed. However, the ship's draft and trim on departure from Port Said and Aden and upon loading in Fremantle must be calculated with care.

Approximate distance and times required between successive points on the voyage are as follows, with times based upon a steaming distance of 350 nm/day:

Fremantle - Aden	4,920 nm	14 days
Aden-Suez	1,310	4
Suez Canal	100	1
Port Said - Cape Torinana	2,475	7
Cape Torinana - Avonmouth	630	2

On the basis that the *Regina Oldendorffs* consumption is 37 tonnes of fuel and 2 tonnes of diesel per day (not her real consumption-see Chapter 1) and that she maintains her supply of fresh water by manufacturing it whilst on passage, the difference in displacement between Cape Torinana and Port Said will be 39x7 = 273 mt. Given that the tonnes per centimetre immersion value for the *Regina Oldendorff* at loaded draft is 38.5, mean draft on departure from Port Said will be 7 cm greater than draft at Cape Torinana. The difference between summer and winter marks is 21.3 cm, so the vessel should have no difficulty in complying with the limit when leaving Port Said. Her summer marks will be well above the water.

From this it follows that keeping the tropical marks above the water will present no problems when leaving Aden, only five days earlier. The mean draft will be 5 cm deeper, well within the tropical allowance of 21.3 cm.

If the *Regina Oldendorff* had left Fremantle with 26,587 mt of cargo and with 1,027 mt of other weights as itemised above, her draft on sailing (from the ship's hydrostatic tables) would have been 10.13 m. These results, all calculated from the limiting condition at Cape Torinana, can be summarised as follows:

Point	Limit	Limiting Draft	Actual Mean Draft
Load Fremantle	Summer marks	10.24	10.13
Depart Fremantle	Port limit	12.65	10.13
Arrive Aden	Port limit	11.50	9.99
Depart Aden	Tropical marks	10.45	10.15
Suez Canal	Canal limit	16.20	10.11
Port Said	Summer marks	10.24	10.10
Cape Torinana	Winter marks	10.03	10.03
Avonmouth	Port limit	10.38	10.01

Since the actual mean draft is always shown to be less than the limiting draft, this confirms that entering the winter zone off Cape Torinana is the limiting condition for the voyage, provided that the ship can be operated without an excessive stern trim throughout the voyage so that she can arrive at Avonmouth substantially even keel.

With experience, the limiting point in the voyage will often be obvious without the need for detailed investigation such as shown above, but it is essential that every stage in the voyage is considered to ensure that the maximum cargo is carried, and that the vessel is not loaded too deeply at any stage.

Disposition of the cargo

Deciding the tonnage distribution: Having calculated the total tonnage of cargo to be loaded (in the example it is 26,587 mt), it is necessary next to decide upon the tonnage to be loaded into each hold. Many factors have to be taken into consideration when making this decision. Given the right combination of circumstances the decision can be a very easy one but when the requirements are more exacting skill, experience and patience will be required to find the best solution. The steps in the calculation are as follows.

1. **Decide how many holds are to be loaded.** If a full low-density cargo is to be carried, all holds will be loaded, though some may not be full. If a full high-density cargo is to be carried and the ship has been suitably strengthened the loading is likely to be in alternate holds.

2. **Share the total cargo between the holds.** The first tentative (i.e., experimental) sharing of the cargo between the holds can be based upon a standard condition from the ship's stability manual, the tonnages used on a previous voyage, or a sharing based upon proportion. A hold which contains 30 per cent of the ship's cubic capacity can be given 30 per cent of the total cargo. The calculation for the *Regina Oldendorfflooks* like this:

	Grain Capacity (m^3)	Per cent	Tonnage (mt)	Rounded (mt)
Total	34,978	100	26,587	26,600
No.1	6,848	19.57	5,205	5,200
No.2	7,867	22.49	5,980	6,000
No.3	5,503	15.73	4,183	4,200
No.4	8,061	23.04	6,127	6,100
No.5	6,699	19.15	5,092	5,100

The table shows that the capacity of No.3 hold (5,503 m^3), for example, is 15.73 per cent of the vessel's capacity, so 15.73 per cent of the total tonnage (4,183 mt) can be carried there. The rounded distribution shown in the final column is simply a convenient starting point for the calculations which must follow.

3. **Place fuel, fresh water and other weights in the positions intended for departure from the loading port.** A position for the centre of gravity of each item of weight must be used in the calculation. This raises important considerations (which are discussed in Chapter 10 under the heading 'Centres of Gravity to be Used').

4. **Calculate the ship's draft and trim on departure and ensure that they are acceptable.** The mean draft will be as required, unless a mistake has been made. If the trim is not as required a rearrangement of the cargo between holds must be made.

5. **Calculate the ship's stability characteristics on departure and ensure that they are acceptable.** They will not be acceptable if they fail to meet the minimum requirements stated in the ship's loading manual - these will normally be the requirements stated in the International Load Line Convention 1966, Regulation 10, Annex I, or the equivalent national regulations.

6. **Calculate the shear forces and bending moments on departure and ensure that they are not excessive.** The maximum allowable still water bending moments and shear forces will be stated in the loading manual. The in-port values do not apply when the ship goes to sea; the at-sea values must be used. Where two alternative values are provided, one set for alternate hatch loading and the other for ballast or uniform loading, the appropriate set must be used. In the longhand calculations of longitudinal strength for some vessels a separate 'bulkhead factor' is used to reduce the calculated values of shear forces. This correction should be applied strictly in accordance with the instructions in the stability booklet. The bulkhead factor takes account of the fact that some of die load caused by cargo in adjacent holds is transferred to the transverse bulkhead through the double-bottom structure instead of the side shell plating. Computerised loading programs offer the operator the opportunity to make this correction. If he chooses not to apply the correction the resulting error will be a safe one; the shear forces will appear higher than they really are.

7. **Check that the tonnage allotted to each hold is not greater than die classification society permits.** This check is important to ensure that the ship is not overstressed, but often the requirement is not clearly stated in the loading manual, particularly on older ships. The maximum tonnage, when plainly stated, may be a single sum, or the permitted tonnage may vary with the draft of the ship. In some loading manuals the permitted tonnage is not stated. In such cases the ship may be put at risk if any hold is loaded with more cargo than is shown in any of the standard conditions of loading contained in the loading manual. When such a loading is proposed, masters are advised to consult the classification society, through their owners. This matter is fully discussed in Appendix 9.2. The unintended overloading of a hold is most likely to occur when loading a high-density cargo in alternate holds and when loading to tropical marks. Unintended overloading may also occur when extra cargo is carried because only a small quantity of bunkers has been loaded, or when several parcels of cargo are loaded, requiring uneven distribution between holds.

8. **Check tiiat the hold tanktop, or double-bottom, loadings are not excessive** when the cargo is one such as steel coils or slabs. Permissible tanktop loadings are imposed to prevent damage to the internal structure of the double-bottom tanks. They are normally expressed in tonnes per square metre (t/m^2). If the maximum tonnage of steel coils or slabs per hold is calculated from *tanktop area x permissible loading* the maximum tonnage will normally be less than that allowed for alternate hatch loading. In other words, the tonnage of ore which can be carried in a strengthened hold is greater than the tonnage of steel which can be carried, unless a special assessment has been made by the classification society, taking account of the ship's structure. Provided that a cargo of steel is distributed throughout all holds, and not placed only in the strengthened holds, there should be no difficulty in loading a full cargo.

9. **If the ship is to be block loaded ensure diat the loadings for individual holds remains within the special block loading limits set by the classification society.** Block loading is the name given to a loading in which adjacent holds are heavily loaded whilst one or two remaining holds are empty. Block loading is likely to be proposed when several parcels of closeweight cargo are to be loaded or discharged at different berths, or in different ports. It may also be proposed as a means of reducing the longitudinal stresses which occur when a vessel is jump loaded. The problems associated with block loading are described later in this chapter, and full details appear in Appendix 9.4. If block loading is planned and the ship has not been provided with a statement of maximum tonnages for use with block loadings they must be requested from the classification society, through the owners.

10. **Work dirough the voyage stage by stage,** adjusting bunker quantities to reflect bunkers consumed and taken, and repeating the calculations at steps 3, 4 and 5 for arrival at and departure from each port.

11. **If any of the above steps gives an unacceptable result the cargo tonnages or otiher weights must be redistributed,** and the calculation must then be repeated.

12. **When an acceptable cargo distribution has been produced it must be carefully reconsidered to see** whether any errors have been introduced. For example, is there room in the hold for the amended tonnage allotted to it? Can the tonnage distribution between holds be further amended in any way that will help to speed loading or discharge?

Reasons to amend the tonnage distribution: Results that would be unacceptable include insufficient positive stability, excessive shear forces or bending moments, or excessive tanktop or hold loadings. Also unacceptable would be a large trim by the stern which makes the ship's draft too deep to enter or leave a port, or a large trim by the head which is likely to make the ship steer badly and which usually makes it difficult to draw fuel from forward bunker tanks to the engineroom.

In the case of a bulk carrier which is normally sagged when fully loaded, it is worth examining the possibility of putting increased tonnages of cargo in the end holds and reduced tonnages in the centre holds to reduce the sag, provided that this does not take bending moment and shear force values close to the limits.

It is sensible to respect the wishes of the chief engineer, as far as possible, with regard to the most convenient bunker tanks in which to carry the bunkers. Such tanks will usually be close to the engineroom. The voyage plan should not involve the transfer of bunkers, except from bunker tank to engineroom, since any other transfer of fuel increases the risk of spillage and pollution.

Guidelines for amending the tonnage distribution: It is most unlikely that the first attempt at distributing the cargo between the holds will satisfy all the requirements. It is much more likely that the calculations will show that the ship's trim, stability or stresses will be unacceptable at some stage in the voyage. When this occurs there are several useful guidelines to keep in mind when redistributing the weights throughout the ship:

1. Wherever possible an unacceptable trim should be corrected by repositioning cargo, not bunkers. If the cargo can be positioned so that the draft and trim throughout the voyage are acceptable, then the possibility of repositioning bunkers can be kept in reserve for emergencies.

2. A ship on passage often has spare lifting capacity, except at the limiting point of the voyage. At such times it may be possible to take ballast, ideally in the forepeak or

afterpeak tank, to improve the trim or stability without exceeding the permitted draft.

3. Transferring bunkers within the ship should be avoided as far as possible to reduce the risk of a spillage. If bunkers must be transferred, the transfer should be by gravitation if possible. Preplanning which ensures that the bunkers are loaded into the most suitable tanks and consumed in the optimum sequence is better than the transferring of bunkers.
4. Insufficient positive stability in seaworthy bulk carriers is a problem which is normally met only in vessels carrying forest products. In brief this problem is countered by keeping the number of slack tanks to a minimum, keeping bunkers (both water and fuel) as low as possible in the ship, keeping ballast tanks filled, and if necessary carrying additional bunkers to act as ballast.
5. When rearranging the cargo aboard a vessel to alter the ship's trim or stresses a few simple rules may be useful.
   - To reduce trim by the head, or increase trim by the stern, move a weight aft.
   - To reduce hogging stresses move weights from forward and aft towards midships.
   - Aboard Panamax and Cape-sized bulkers where alternate holds are the same length, it is usually possible to reduce longitudinal stresses whilst maintaining the same trim by moving two equal weights in opposite directions at opposite ends of the ship. For example, to reduce a shear force at No. 9 hold, move 200 tonnes of cargo from No. 9 to No. 7 hold, and balance that by moving 200 tonnes from No. 1 to No.3 hold. This may have unexpected effects upon bending moments so they must always be rechecked after weights have been moved.

Loading/deballasting programme

The Nautical Institute's Cargo Operations Control Form: When a satisfactory distribution of cargo has been obtained, a programme must be devised for loading the cargo whilst keeping stresses within the permitted limits throughout the process and always maintaining a stern trim to assist efficient deballasting. Limited depth of water and height below the loading arm may restrict the draft and air draft which can be accepted.

The programme should provide all the information required by deck officers and loading personnel, presented in a clear and logical manner. The Nautical Institute has devised a Cargo Operations Control Form (Appendix 9.3) for this purpose, and has recommended that the form should always be completed, and a copy passed to the authorities ashore, before commencement of loading. Copies should be available as working documents ashore and aboard, and a copy should be filed aboard ship as an actual record of the cargo and/or ballasting operation. (A blank form is provided on the inside back cover.)

The loading programme lists each step in the deballasting, and the corresponding cargo pour. (A pour is the quantity of cargo poured into one hold as one step in the loading programme. Other expressions sometimes used for a pour are a 'run', a 'shot' and a 'drop'.) A pass is composed of a pour into each of the holds to be loaded. Thus a ship loading five holds with 30,000 tonnes of cargo might load with a first pour of 3,000 tonnes in each hold. When the first pass was completed 15,000 tonnes would be distributed between the five holds. The second pass would be composed of a second pour of 3,000 tonnes into each of the five holds.

Information required for preparation of loading/deballasting programme: If a realistic loading/deballasting programme is to be devised, the following information is required:

- Maximum safe draft in berth.
- Minimum depth in the approach to the berth.
- Tidal range.
- Maximum permitted sailing draft.
- The minimum air draft beneath the ship loader.
- Characteristics of loading equipment.
- Limits of movement of the loading equipment.
- The maximum theoretical loading rate.
- The number of ship loaders to be used.

(These requirements are discussed in greater detail in Chapter 11.)

Guidelines for preparation of a loading/deballasting programme: As a starting point it is normal to assume that each pour will consist of about half the total tonnage to be loaded into the compartment in question. The loading sequence (or loading rotation) depends upon the size of ship and the number of holds to be loaded, but some guidelines can be offered.

1. The first pour should where possible be into a midship or after hold to provide or maintain a reasonable trim by the stern for ballast stripping purposes.
2. If the air draft is restricted it will be necessary to make the first pour into a hold which causes some increase in forward draft to ensure that the loading spout can continue to clear the heath coamings of the forward holds.
3. If the air draft is restricted the effect of a rising tide must be considered and deballasting cannot continue when the clearance is small.
4. Successive pours should alternate between forward and after holds to maintain a reasonable trim by the stern.
5. The end holds (i.e., the foremost and aftermost holds) have the biggest effect upon trim. Where possible they should receive the last pours of the first pass, and the first pours of the second pass, because the resulting large changes in the trim and maximum draft are likely to be least inconvenient at that point.
6. The ballast which is likely to present most problems should be discharged first, the normal sequence commencing with ballast holds, continuing with double bottom tanks and wing tanks and concluding with peak tanks.
7. Ballast should normally be discharged from a position close to the one where the cargo is being loaded at that time. For example, No.3 double bottom should be discharged whilst No.3 hold is being filled, if No.3 double bottom is below No.3 hold.
8. The time required for a deballasting step should be matched with the time required for a loading pour. A pour of 3,000 tonnes at a loading rate of 1,500 tonnes/hour will take two hours. This should be programmed with a deballasting step which will take less than two hours, so as to reduce the likelihood that the deballasting will overrun, and become out of step with the loading.

9. The ballasting should be programmed to be completed several hours, at least, before completion of loading, and at a time when the vessel still has a stern trim, to assist the deballasting and stripping.
10. On many bulk carriers trim can be quickly and conveniently changed by pumping ballast directly from forepeak to afterpeak, or vice versa.
11. Rules imposed by the Classification Society and quoted in the loading manual may restrict the sequence of loading: they must be strictly observed. For example the manual may state that no hold can be completely filled until the mean draft is at least two thirds of the intended sailing draft.
12. In exposed berths the ship should be maintained at a draft and trim at which she can put to sea at short notice if required. This precaution is particularly recommended in areas where ports must be evacuated on the approach of a tropical storm.

Calculation of the loading/deballasting programme: From a starting point with the ship in ballasted condition and ready to commence loading, calculations must be undertaken for each step in the loading programme. These calculations are similar to those already undertaken for each stage in the loaded voyage, and are intended to find the ship's draft, trim, stability and longitudinal stresses at each stage in the loading. They are essential to ensure that the ship is not subjected to excessive bending moments and shear forces during the course of the loading, and their importance cannot be overstated.

Whenever the calculations show that the draft, trim, stability or stresses at the end of a stage are unacceptable, the programme must be changed by changing the loading or deballasting sequence or quantities. Unfortunately it is sometimes necessary to amend a number of earlier stages to remove a problem which arises in the later stages. When this occurs the data for all the stages which have been amended must be recalculated.

When rearranging the ballast and the cargo pours aboard a vessel to alter her trim or stresses the rules quoted earlier are still applicable:

- To reduce trim by the head, or increase trim by the stern, load cargo aft or discharge ballast from forward.
- To reduce hogging stresses load cargo amidships or discharge ballast from the forward and after ends of the ship.
- To reduce shear forces and bending moments whilst maintaining the same trim move two equal weights in opposite directions at opposite ends of the ship.

Ways of adjusting the loading/deballasting programme: Sometimes it will be found very difficult to devise a loading/deballasting programme which remains within the stress limits. This is most likely to occur when loading a high density cargo in alternate holds (jump loading), or when planning the loading of a segregated part cargo which is not to be distributed between all holds. Difficulties are more likely if the ship is observing the at-sea stress limits whilst in port to increase the safety margin and reduce the danger of structural damage to the ship during the loading process.

Several steps can be recommended to reduce the calculated stress values and improve the programme.

- The pour sizes can be varied. Better results may be obtained if 60 per cent, say, of the tonnage is loaded in the first pour, and 40 per cent in the second, or vice versa.
- The number of pours can be increased, using three pours in holds where two give difficulties. Since each shift of the loading spout will take 10 minutes or so, this will slightly increase the time required for loading, making this option less attractive than safer loading achieved by varying the size or the sequence of the pours.

Loading when the ship is too long for the berth: If the ship is too long for the berth, so that the loading spout cannot reach all holds without the vessel shifting, the plan should require the ship to shift along the quay as seldom as possible. This can probably be best achieved by commencing loading in an after hold, the forward hold being beyond the end of the berth. Then, after about one-third of the cargo has been distributed between holds except No.1, the vessel should be moved astern to allow a first pour into No.1, followed perhaps by a second pour into an after hold – though not the aftermost one, which would be beyond the end of the berth. This could be followed by a second pour into No.1 hold, after which the vessel would be moved ahead and loading would be completed in the remaining holds. Loading the forward hold is likely to cause a bigger change of trim than loading the after hold, so it is better for the former to be loaded midway through the programme.

A possible loading sequence for a nine-hold bulk carrier loading alternate holds is:

3, 9, 5, 7,
move astern
1, 7, 1,
move ahead,
9, 3, 5, trim.

Planning two-port or two-grade loadings

It is quite common for bulk carriers of all sizes to be instructed to load several different grades of cargo, to be stowed in separate holds. Such different grades may be for loading and discharge at separate berths or even in separate ports. The loading orders quoted at the start of this chapter refer to such cargoes.

This sort of requirement can usually be satisfied by using a distribution with grade A shared between forward and after holds, and grade B treated similarly. If there is a bigger quantity of one grade than of the other, that grade can be allotted to an additional hold, amidships. Possible distributions include:

Hold	9	8	7	6	5	4	3	2	1
Option 1	**A**		**B**		**A**		**B**		**A**
Option 2	A	B	A	B	A	B	A	B	A
Option 3	A	B	C	A	C	A	C	B	A

These and any other distributions are acceptable provided that draft, trim, tanktop loadings, hold loadings, shear forces and bending moments are within acceptable limits throughout the loading, the voyage and the discharge. There is another condition which must be satisfied: if block loading is used it must only be used in a manner which is safe.

Planning should take account of the fact that it is usually desirable (and sometimes essential) to load all of one grade of cargo before commencing to load a second grade, even if both grades are to be loaded at the same berth. One reason for this is that there may be a requirement for a draft survey on completion of each grade to obtain a ship's figure for tonnage loaded. Furthermore, when grades are changed, it is usually necessary for the conveyor belts to be cleaned after completion of one grade and before commencement of loading the second grade. Even if it is possible to switch back and forward from one grade to another time will be lost and inconvenience will be suffered whilst the belts are cleaned.

When planning the loading of several parcels of cargo the discharge must also be planned and checked to ensure that every stage in the voyage will satisfy all the requirements. If grade A is to be loaded and then grade B, and if at the discharge port grade B is to be discharged and then grade A, it is likely that the discharge process will be as safe as the loading process, since one is the mirror image of the other. Even in this case it will be necessary to take account of the effect of differences in the bunker quantities carried.

When the discharging sequence is not a mirror image of the loading sequence the discharging programme must be calculated, before loading, with the same care as the loading programme. If this is not done it may be discovered, too late, that the cargo cannot safely be delivered and discharged in the sequence required.

Block loading

Block loading is the name given to a loading in which adjacent holds are heavily loaded whilst one or two remaining holds are empty. The requirement to load and discharge a number of parcels of closeweight cargo in several loading and discharge ports or berths sometimes leads to the use of this method of distributing the cargo between holds. The decision to use one or two extra holds when carrying a high-density cargo in alternate holds has the same effect. Block loading places an increased load on the transverse bulkhead between the two full holds and this, in turn, increases the load on the cross-deck structure.

Block loading has been commonplace in bulk carrier operations for many years. Naval architects had not realised that block loading was being used and has issued no warnings against it. In 1993 it was reported by IACS that a number of large bulk carriers had experienced structural damage affecting the cross-deck structure which separates adjacent cargo hatchways at the upper deck level. All the damaged ships had completed a voyage with two adjacent hatches heavily laden.

The attitude of the International Association of Classification Societies (IACS) to the question of block loading is stated in Appendix 9.4. Their advice can be summarised as:

- Never exceed the maximum permitted load in any hold.
- When using alternate hold loading use only the holds specified in the loading manual.
- If it is necessary to depart from the above, and if the ship has not been provided with approved block loading conditions, consult the classification society.

Classification societies have provided some ships with approved plans for block loading with close-weight cargoes. A feel for the factors involved may be obtained from the example quoted in Appendix 9.4. This demonstrates that the maximum permitted load for two adjoining holds is much less than the sum of their individual maximum permitted loads.

Two-loader and multi-loader operations[37]

When two loaders are available the ship is divided into two, and each loader works its own end. The loading programme devised for a single loader is normally suitable for two-loader loading, provided that the rate of deballasting is sufficiently high and that the original deballasting programme can be followed in step with the loading. As with loadings with a single loader, stern trim should be maintained, but extremes of trim that may cause clearance difficulties should be avoided. Appendix 9.5 contains a typical loading for the mv *Iron Somersby* for one-loader operation and the same loading adapted for two loaders.

It must be remembered that a second loader does not necessarily mean a doubling of the loading rate, that two loaders are seldom available for the entire loading and that variations in the pouring rate are likely. Extra vigilance is required when different grades are being loaded.

When loading with two loaders both must plumb the centre line to avoid twisting the ship's hull. This is most important as a ship which is kept upright by loading to starboard of the centreline in No.3 hold, say, and to port of the centreline in No.7 hold will be subjected to cargo torque, or twisting of the ship, which may cause serious damage to her structure. If troubles with ballast occur the first response should be to stop one loader.

Because of their size, loaders usually require at least one hatch between them. This should cause no problem to the ship as it is generally undesirable to load adjacent hatches. When it is not certain whether one or two loaders will be used it is prudent to plan for two, adopting a plan which is also suitable for one loader. At some grain terminals up to five spouts may be used to load. Loading a low-density cargo in so many positions simultaneously will eliminate trim and longitudinal stress problems provided that a sensible distribution of cargo loaded is adopted.

Trimming pours

Reasons for the trimming pours: It is normal to complete the loading of a bulk cargo with the trimming pours, a final quantity of cargo kept in reserve to be loaded partly into a forward and partly into an after position as necessary to bring the vessel's mean draft and trim to the desired values. The trimming pours are necessary to compensate for inaccurate quantities loaded, failure to load the cargo in exactly the positions intended, inaccuracies in the loading calculations and/or error in the assumed position of the tonnage constant.

Tonnage set aside for the trimming pours: If the tonnage set aside for the trimming pours is too great, new errors may be introduced and the results of the pours may differ a little from those intended. On the other hand, if the tonnage allowed is too small and at the same time the tonnage supplied by the loader is inaccurate, as it often is, the ship may be brought very close to her marks before trimming commences, leaving insufficient cargo for whatever adjustment of trim is needed. Typical tonnages allowed for trimming are:

Vessel	Dwt	Trimming (mt)
Cape-sized	170,000	5,000
Panamax	85,000	2,500
Handy-sized	27,000	1,000
Mini-bulker	3,000	300

Other authorities[37] recommend as much as 20 per cent of the total cargo.

Choice of holds for the trimming pours: The basic requirements for trimming pours are two loading positions, one of which will cause trim by the head and the other trim by the stern. Provided that only one grade of cargo has been loaded, a number of options for trimming are likely to be available, with some larger ships favouring the end holds (Nos.l and 9) and others preferring to use another combination, such as Nos. 3 and 7. When the loading berth has a limited draft, holds Nos.3 and 7 are likely to be preferred as they will cause smaller changes in the draft during the final stages of the loading and create less risk that the vessel will touch bottom in the berth.

Aboard mini-bulkers with only one or two holds, it is normal to load in several positions in each hold and the trimming can be done using a single calculated position within the forward hold. Unlike the trimming aboard a larger vessel, which offers the choice of applying trim by the head or trim by the stern, the trimming aboard a mini-bulker always starts with the ship trimmed well by the stern, so that trimming is concerned simply with the calculation of how much trim by the head is required to bring the vessel to the desired trim. Put another way, trimming on larger bulkers requires a decision as to how much cargo to put in a fixed position forward and how much in a fixed position aft. On a mini-bulker the question is different: how much is to be loaded in the forward hold, and where in the hold must it be loaded?

In general terms a trimming pour in the fore end of the No.l hold of a mini-bulker will eliminate the stern trim and bring the vessel to an even keel, whilst a trimming pour in the after end of the hold will cause a smaller trim change. The ability to choose intermediate positions along the length of the hold permits more precise adjustments to be made to the trim. An example of this calculation is to be found at Appendix 9.6.

Apportionment of the trimming pours: The tonnage set aside for the trimming pours must form part of the tonnage already planned for the ship, and must therefore be deducted from the tonnages allotted to the holds where the trimming pours are to be delivered. It is necessary to decide what proportion of the trimming quantity is to be deducted from the hold total of each of the two holds. Simply put, the rule is: take the larger quantity from the hold with the larger trimming moment.

The explanation for this approach is as follows. If there are no trimming errors to correct and the draft and trim are exactly as required, then the quantities set aside for trimming will be loaded in the positions originally chosen for them. If, however, there are errors in trimming to correct, it will be necessary to transfer some of the cargo planned for one trimming position to the other. In that case a greater tonnage will be needed to obtain a given amount of trim change in a position with the smaller trimming moment, and that tonnage must be available from the tonnage intended for the position with the larger trimming moment.

For example, in a Panamax vessel: 1,000 mt in No.3 hold causes trim change of 47.5 cm, and 1,000 mt in No.7 hold causes trim change of 27.0 cm. If the trimming quantity is to be 2,500 mt: 2,500 x 47.5/ (27.0 + 47.5) = 1,594 mt $\simeq$ 1,600 mt; 2,500 x 27/ (27.0 + 47.5) = 906 mt $\simeq$ 900 mt. In this example No.3 hold has the larger trimming moment, so 1,600 mt will be taken from No.3 for trimming, and 900 mt from No. 7. This will ensure that the same amount of trim change can be achieved, if necessary, by the head as by the stern.

Trimming pours in the loading programme: When the quantities intended for the trimming pours have been chosen, the loading programme must be adjusted to show the trimming quantities. If hold No.3 was planned to load 16,000 mt, with a first pour of 8,000 mt and a second pour of 8,000 mt, this would be adjusted to give: first pour, 8,000 mt; second pour, 6,400 mt; and trimming pour, 1,600 mt. After this, the amended pours into the two trimming holds must be checked to ensure that they still provided acceptable draft and trim, and values for longitudinal stress at every stage in the loading.

Implementation of the trimming pours: Trimming pours are included in the loading programme because experience shows that the ship's draft and trim in the later stages of loading are seldom exactly in accordance with the calculated values. When the time for the trimming pours is reached loading is halted and a draft survey is performed to determine precisely the tonnage of cargo remaining to be loaded.

This survey may be done by an appointed surveyor, who will then agree the final tonnage for the trimming pour, or it may be done solely by the chief mate, to ensure that the ship is given the tonnage required to ensure the correct final draft and trim. In the latter case, the draft surveyor, if appointed, will only attend when all loading is completed. It is quite normal for the draft survey to show that the actual tonnage required and the trim observed are both slightly different from those previously calculated.

There are several manual methods for calculating the trimming quantities to be placed in each hold when it is time to make the trimming pours, though surprisingly the calculation is not normally to be found in computerised loading programs.

A reliable and accurate calculation is to be found at Appendix 9.7. If the available figures are pre-entered, the calculation can be completed quickly with the aid of a hand-held calculator when the drafts have been obtained. The tonnages calculated for trimming can then be double-checked against the ship's trimming tables to confirm the tonnages required, in a process which need take no more than ten minutes.

Another method for calculating the quantities required for the trimming pours is simply to use the trimming tables, using a trial and error approach. For example, if the trimming quantity was 1,770 mt an officer would take from the trim tables the trim changes resulting from placing 1,000 mt in No.7 hold and 770 mt in No.3 hold. If, when totalled, they showed too great a stern trim he would try again, using 900 mt in No.7 hold and 870 mt in No.3 hold, and so on, until the correct figures are obtained. This method is not recommended as it is cumbersome and its accuracy depends upon the degree of accuracy contained in the trimming tables and the care with which they are interpolated.

Changes in hog or sag during trimming: When calculating the tonnage required for the trimming pours it is normal to assume that any existing hog or sag will remain throughout the trimming pours, but this may not be so. If the trimming pours are placed in the end holds (e.g., Nos. 1 and 9) any existing sag will probably be reduced. On completion of the trimming pours it will be found that a little more cargo is still required to bring the vessel to her marks. If the trimming pours are made into amidships holds such as Nos.5 and 7 any sag is likely to be increased by the trimming. If this happens the vessel will be found to be overloaded on completion of trimming.

When using midships holds for trimming on larger vessels it is prudent to subtract a small quantity of cargo from the trimming tonnages to allow for sag which increases during trimming, and so to avoid overloading. This quantity can be loaded by additional trimming pours if draft readings on completion of the first trimming pours show that there is still capacity for it.

Trimming in end holds or in midships holds makes no difference to the tonnage lifted by a vessel which loads exactly to her marks. The tonnage lifted is governed by whether the vessel is hogged or sagged and this depends upon the total tonnage loaded in each hold. The total tonnage in the hold is unaffected by whether it is loaded in, say, two pours, or two pours plus a trimming pour.

Trimming in marginal conditions: One authority[37] reports that difficulties in trimming are likely to be experienced with borderline cargoes such as dolomite, limesand and clay, which have stowage factors very close to that required to fill the ship homogeneously whilst also bringing her to her marks. Such a ship may reach her marks before all spaces are filled, or alternatively may be filled before she is down to her marks. The chief mate trying to trim the ship may find that he has run out of space in which to place the cargo required for the trimming.

To avoid being caught in this situation it is recommended that the loading is interrupted with about 70 per cent of the cargo loaded. By this time at least one hold should be completely filled and all the ballast should be discharged. The stowage factor should be recalculated from the full hold, provided that a reliable figure for tonnage loaded in that hold can be provided, and the remaining loading of the cargo should be recalculated and if necessary replanned.

Loading the optimum amount of cargo

Requirement: From time to time bulk carriers are required for commercial reasons to carry less than a full cargo. The master will find that although his vessel can lift 27,000 mt she is instructed to carry only some lesser tonnage or, when loading a low-density cargo, space remains when all the cargo allocated to the ship has been loaded.

However, such occasions are rare and it is more usual for the earnings of the owner and/or the charterer to depend upon the tonnage lifted. When that is the case it is the responsibility of the master to do his best to ensure that the maximum amount of cargo is carried.

To achieve this the ship must be loaded to the appropriate limiting draft, or all her cargo spaces must be efficiently filled, but in addition to such practical matters careful planning is required to keep other weights to a minimum when a high-density cargo is being carried since every extra tonne of fuel or water carried means one tonne of cargo rejected.

Bunkers: The master often controls the quantity of bunkers which the vessel carries, since on most voyages he is instructed to order sufficient bunkers for the forthcoming voyage, plus a specified tonnage in reserve. If the master, in consultation with the chief engineer, underestimates the tonnage of bunkers required the ship will be forced to proceed at slow speed, to purchase bunkers in a more expensive alternative port, or to burn expensive diesel oil. Otherwise she will run out of fuel. Since all these options are unattractive, there is pressure on the ship's officers to overestimate their bunker requirements rather than to underestimate them, and there is a danger that this process can be carried to excessive lengths.

There is one acceptable reason for appearing to carry extra bunkers. The ship's bunker tonnages usually include an unpumpable quantity of fuel which will be left in bunker tanks after they have been drained as much as possible. Since the unpumpable tonnage cannot be used, it must be excluded from the calculation of tonnage required.

Such a calculation for fuel oil for the *Regina Oldendorff* might look like this:

Voyage: 32 days at 31 tpd		992 mt
Reserve: 3 days at 31 tpd		93
Total required for voyage		1085 mt
Quantity aboard	327 mt	
Unpumpable	35	
Rsable fuel aboard	292 mt	292
Tonnage to order		793 mt

The usual convention is that fuel in the settling and service tanks, normally equal to about one day's consumption, is not included in the quantity aboard. This provides an additional reserve.

The foregoing figures justify an order for 800 mt of fuel oil bunkers. This would provide for the intended voyage with the required margin of safety, plus the small additional margin provided by the contents of the settling and service tanks. It would be bad practice to order more than 800 mt of fuel oil since that would be to shut out cargo to carry unnecessary bunkers.

The requirement for diesel is less easy to predict since it is used in port as well as at sea, and since time in port, the working of ship's cargo gear, and port manoeuvring are not entirely predictable. For that reason, and because diesel can be used to fuel the main engine at sea, it is quite common to carry 30-50 mt of additional diesel aboard ships where daily consumption of this fuel is only 2-4 mt.

There are occasions when it makes good economic sense to carry extra bunkers, because the opportunity to purchase cheap bunkers is worth more than the freight earned by carrying an equal quantity of cargo. This is a decision which will be taken by the owners or charterers since it is unlikely that the master will have sufficient facts at his disposal to enable him to propose such a line of action.

The figures quoted previously illustrate the considerations which must be taken into account when calculating fuel figures, but the actual allowances used depend upon the size of ship, her normal performance, the trade in which she is employed and owners' policy.

Fresh water: Aboard bulk carriers fresh water is used for drinking, cooking and washing, and it may be used for toilet flush systems. It is also used for machinery cooling systems. Most bulk carriers are provided with fresh water generators of one kind or another, and these are designed to manufacture all the fresh water that the ship will require in normal service whilst under way. This means that vessels equipped with reliable fresh water generators need only leave port with sufficient fresh water to last until the vessel is clear of coastal waters which may be polluted, plus a margin for safety. Additional fresh water may be required if a period at anchor is a possibility.

Some charter parties are claused on *the reasonable* assumption that the vessel does have an efficient water generator, and stipulate that the vessel must leave the loading port with no more than five days' consumption of fresh water aboard. There should be no difficulty in complying with this provided that consumption is normal and the equipment is working well.

Ballast stoppings: Careless or inefficient discharge of ballast, or sediment filled ballast tanks, can lead to the retention in the ballast tanks of much larger tonnages of ballast water and sediment than are acceptable. (Measures to reduce ballast stoppings and sediment to a minimum are discussed in Chapter 7.)

Miscellaneous weights: The ship should be checked regularly for the accumulation of unnecessary weight. It is good practice to ensure that chain lockers, void spaces and engineroom bilges are all regularly pumped out, using the oily water separator where appropriate, and it is particularly important that these are checked towards the end of the ballast voyage before reaching the loading port.

Charterparty constant: Some charterparties contain a clause in which a tonnage is specified to cover consumables and miscellaneous weights other than fuel. Such an allowance, say, of 400 mt for a Panamax vessel, covers fresh water, stores, unpumpable ballast, the draft survey constant and any reduction of the ship's lift due to sag. The charterparty constant has the effect of giving the charterer a guarantee as to the cargo the ship can carry, since deadweight minus fuel minus c/p constant equals cargo capacity.

Old bulk carriers which have defective water generators, an accumulated tonnage of spare gear, thick coatings of paint and ballast tanks clogged with sediment will have difficulty in keeping weights within the permitted figure unless it is set at a realistic level.

Hog and sag: A vessel is said to be hogged when the mean draft amidships is less than the mean of the forward and after drafts. This occurs when the hull is curved, with the highest point of the curve occurring amidships. Of a vessel which is sagged, the opposite is true. The mean draft amidships is greater than the mean of the forward and after drafts and the hull is curved with the lowest point of the curve occurring amidships.

Although a ship is built with her keel forming a straight line, her hull possesses flexibility and the distribution of weight that she carries usually causes some curvature in the keel and other longitudinal members once she is afloat. This curvature will vary with changes in the sizes and positions of weights carried and also with time. It has often been observed that the value of a vessel's hog or sag alters during the course of a voyage and this may reflect the conversion of loading stresses into hull deflections as the vessel works in a seaway.

Careful measurements taken aboard large bulk carriers have shown that curvature or distortion of the hull due to distribution of weights aboard is not parabolic and can be quite complex, with some parts of the hull sagging deeper than others. These facts have a bearing upon the calculation of cargo tonnage by draft survey, particularly for the largest vessels, and the best way of taking account of them in draft surveys *remains a matter for discussion.*

The subject is mentioned here because a vessel which is hogged can legally lift a greater tonnage of cargo than the same ship if sagged, as the former vessel has a greater displacement when loaded to her marks than has the latter. Fig. 8.3 illustrates this point. Bulk carriers when loaded conventionally are normally sagged. This comes about because all space amidships is available for cargo and can be filled, whilst spaces forward of the collision bulkhead and abaft the engineroom bulkhead are empty or only part filled when the vessel is loaded.

A bulk carrier's 'official' deadweight is calculated assuming no hog or sag. If the vessel is sagged she will lift less than the 'official' figure, and this has been known to cause disputes between owners and charterers. The value of a vessel's sag can be reduced by reducing the tonnage of cargo carried in midship holds, and increasing the tonnage carried in the vessel's end holds, always provided that shear force and bending moment values are never exceeded.

A Panamax bulk carrier when sagged 10 cm-and this is a modest figure-can lift about 150 mt less than she could lift if in the 'official' condition, neither hogged nor sagged. Reduction of this loss of lifting is a good reason for attempting to reduce the amount of sag, but will never justify exceeding the permitted values of shear forces and bending moments.

When a bulk carrier has a history of being sagged when fully loaded, as most bulk carriers do, it is realistic to recognise the fact, and to take account of it in deadweight calculations prior to loading by including a sag allowance when calculating the tonnage that the vessel can lift. This ensures that the charterers are informed of the ship's actual capacity. The appropriate sag allowance is the average or typical figure observed for sag for recent previous full cargoes, (i.e., it is the average of negative corrections to the displacement in respect of deflection).

Discharging/ballasting programme

The discharging/ballasting programme must be planned in the same way as the loading/deballasting one, and The Nautical Institute's Cargo Operations Control Form provides a useful way of recording the results of the calculations. Provided that a single grade of cargo is carried there will normally be no difficulty in planning a discharging/ballasting programme which satisfies the requirements for draft, trim and longitudinal strength.

If a two-berth or a two-port discharge is required, it may be found difficult to comply with all the requirements. It is essential to make sure before the cargo is loaded that the ship will be safe and can comply with all the requirements throughout the discharge.

When the cargo cannot be carried safely

Sometimes it will be found that there is no way that the proposed cargo can be safely and legally loaded, carried and discharged, because it is not possible to comply with all the requirements listed above. This is most likely to occur with segregated part cargoes for two-port, or two-berth, loading or discharge.

Whilst ship operators are usually well informed about a ship's dimensions and cargo capacity, they may not have the information or the knowledge to plan each step in the loading and to appreciate the insurmountable obstacles which can arise. In these circumstances the master has no alternative but to inform his owners and charterers as soon as possible that the proposed cargo cannot be safely carried. He should be prepared to offer advice as to the best options which can be offered by a change of tonnages or port rotation.

Sources

22. *Code of Safe Practice for Solid Bulk Cargoes.* International Maritime Organization. 1991.

37. Lynch, R. J., *Steel Industry Bulk Cargoes*–a guide for BHP personnel. BHP Transport Ltd. 1980.

CHECKLIST–Procedure for planning the loading

Find maximum the ship can carry when fully laden

- ☐ Deadweight cargo or volume cargo?
- ☐ Decide values of other weights which must be carried. Keep the total weight of bunkers, ballast, bilge water, stores and miscellaneous weights as low as possible.

Identify any limiting stage in the voyage

- ☐ List maximum permitted draft for each stage in voyage.
- ☐ Select point where lightest draft is required (the limiting point).
- ☐ Calculate back and calculate forward from limiting point to ensure no other limits are met.
- ☐ Calculate maximum cargo which can be carried at limiting point.

Devise loading distribution

- ☐ Decide how many holds are to be loaded.
- ☐ Share the total cargo between the holds.
- ☐ Place fuel, fresh water and other weights in the positions intended for departure from the loading port.
- ☐ Calculate the ship's draft and trim on departure and ensure that they are acceptable.
- ☐ Calculate the ship's stability characteristics on departure and ensure that they are acceptable.
- ☐ Calculate the shear forces and bending moments on departure and ensure that they are not excessive.
- ☐ Check that the tonnage allotted to each hold is not greater than the classification society permits.
- ☐ Check that the hold tanktop loadings are not excessive.
- ☐ If the ship is to be block loaded ensure that the loadings for individual holds remain within the special block loading limits set by the classification society and request limits if none has been provided.
- ☐ Work through the voyage and the proposed discharge, repeating the checks upon draft, trim, stability and longitudinal stress for every stage.
- ☐ If any results are unacceptable move cargo or other weights and recalculate. Check the results for errors.

Prepare loading/deballasting and discharging/ballasting plans

- ☐ For the plan use a suitable form, such as The Nautical Institute's Cargo Operations Control Form.
- ☐ Take note of the features of the berth, including least depth of water, least airdraft, number of loaders, distance loaders can travel.
- ☐ Plan for two or more pours into each hold.
- ☐ Commence loading amidships/aft to maintain a stern trim.
- ☐ Load alternatively aft, then forward, then aft, etc.
- ☐ Load the end holds midway through the loading.
- ☐ Discharge ballast from holds, then double bottoms, then topside tanks, and finally peak tanks.
- ☐ Discharge ballast from part of ship where cargo is being loaded.
- ☐ For each stage of the loading, match the time required for loading with the time required for deballasting.
- ☐ Plan to complete deballasting well before completion of loading.
- ☐ Observe any Class rules for loading/discharging.
- ☐ Throughout loading keep ship in condition to put to sea in emergency, if required.
- ☐ Plan suitable trimming pours.
- ☐ Plan the discharge in the same manner and with the same objectives as the loading.
- ☐ Ensure that the ship complies with requirements for stability and for longitudinal stress at every stage throughout the loading and discharge.
- ☐ Inform owners/charterers as soon as possible if calculations show that the proposed cargo

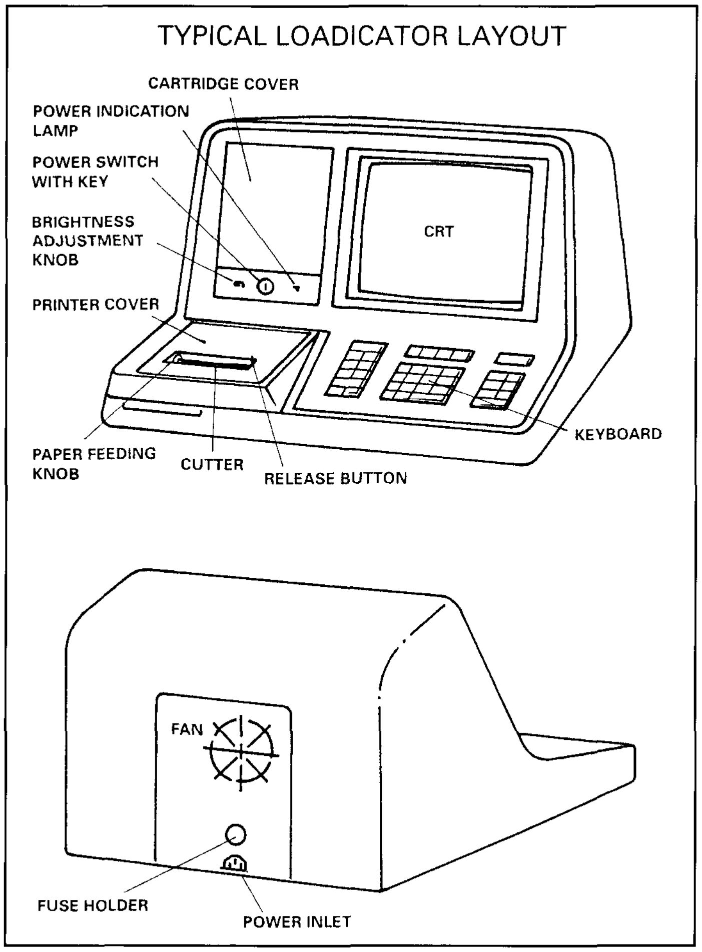


DIAGRAM OF DRAFT CORRECTION

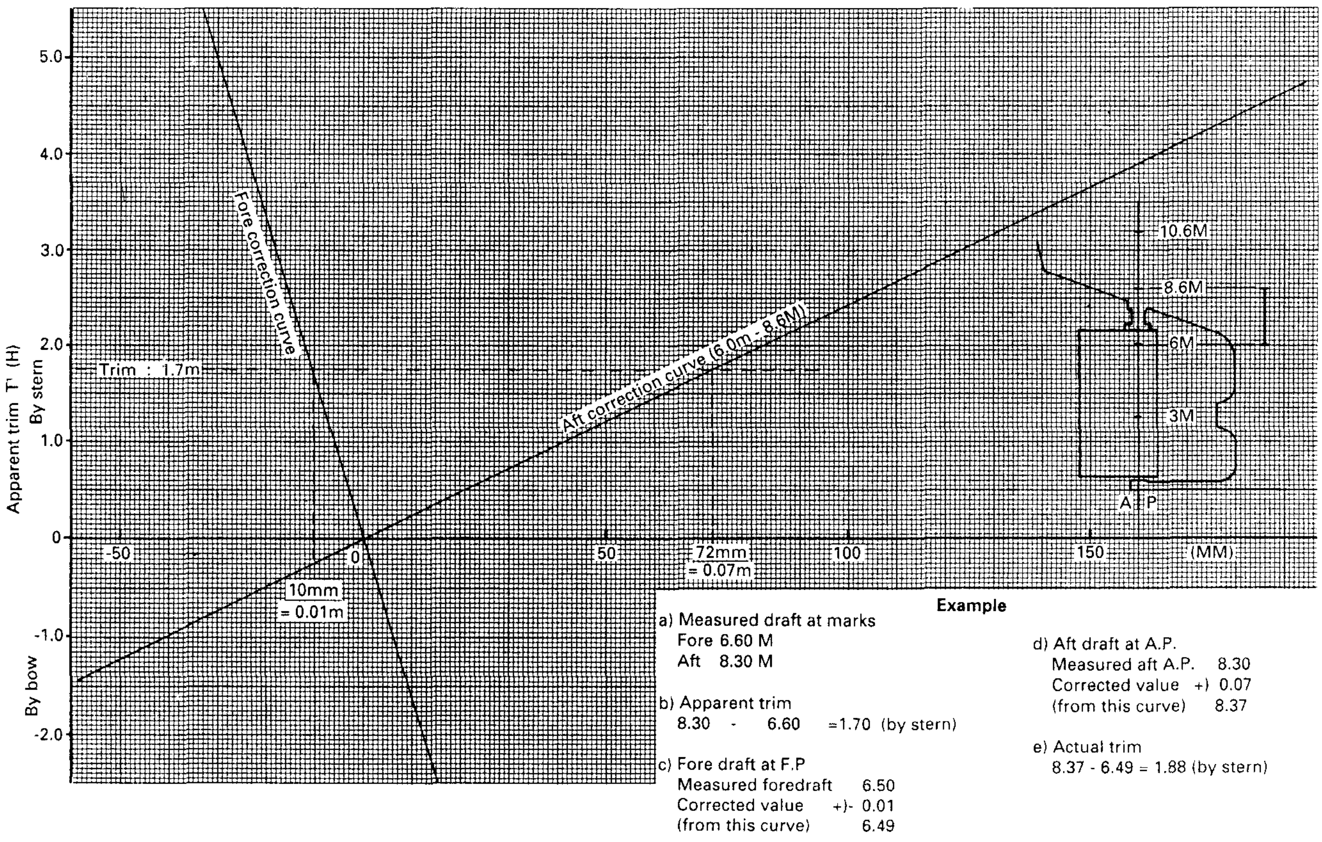


FIG 10.4

Chapter 10

LOADING CALCULATIONS

Loading computers, the use of loading manuals, their deficiencies and contents, displacement, stability and longitudinal strength calculations, choice of methods, practical considerations, grain stability, timber stability

Abbreviations used in stability calculations

IT IS an unfortunate fact that a great variety of abbreviations are used for stability expressions in the documents supplied to ships. In most cases the use of abbreviations has been avoided in this book to avoid confusion, but a table of abbreviations which are commonly used is at Appendix 10.1.

Equipment required for planning the loading

Planning the safe and efficient loading of a bulk carrier is a vitally important process, which makes it essential that the documents, information and equipment for planning the loading are easy to use and readily available. On many ships these conditions are not satisfied and The Nautical Institute strongly recommends that ships' managements, shipmasters and other interested parties ensure that the following guidelines are applied aboard the ships for which they are responsible.

It is not acceptable for ships to use dirty, dog-eared and illegible loading manuals for planning the loading, nor for officers to be provided with loading instructions and guidance which is badly composed and written in broken English or in another language that they cannot understand. The value of a loading computer or loadicator is much reduced when its instruction manual has been lost, and problems are likely when all copies of the ship's stability software are on floppy discs, loose and unprotected, in a dirty drawer in the ship's office. When the computer is faulty and the printer has broken down it is not sufficient to list it for repair when the ship next enters dry-dock, 18 months later. Regrettably all the foregoing conditions are quite common, and where they exist there is very little chance that the ship will be loaded safely and efficiently.

Loadicators and loading computers-the equipment: Loadicators and loading computers are similar instruments, the principal difference between them being that a loading computer is a conventional computer which can be used for a variety of tasks, including loading calculations, depending upon the software used with it whilst a loadicator is made only for loading calculations and cannot be used for ship's accounts, spare parts records or word processing.

A ship equipped with a loadicator or loading computer should have evidence that the instrument has been approved by her classification society. This may consist of a brass plate, firmly attached to the side of the equipment, showing the classification stamp and the surveyor's initials, or of a certificate issued by the classification society and displayed on the bulkhead by the equipment.

The instruction book for the instrument is usually one of the listed plans for the vessel and will normally contain either the classification stamp or a statement that the loading computer has been approved. At least two copies of the instruction manual and of the test conditions or test report should be available, one of these to be a fair copy to be kept in the master's care, available for copying when the working copy becomes damaged and difficult to use.

Older hardware may consist of a plan of the ship with lights to indicate percentage bending moments and shear forces, and a small digital panel to display the values at a chosen frame. More modern equipment will consist of a monitor (cathode ray tube), a keyboard, a printer and the memory, and in the case of the loadicator all these may be assembled in a single unit (Fig. 10.2). The loadicator's memory or the hard disc of the computer contains all the ship's stability data.

When the instrument is a computer, a succession of 'pages' can be displayed on the monitor, providing the opportunity for the user to enter or change the details of any proposed loading, which the user inputs with the keyboard. The data which the user enters are displayed on the monitor. When so instructed the instrument calculates the trim, stability and strength characteristics of any proposed loading. In most cases the instrument is connected to a printer and can print out a full standard printout of the results (Appendix 10.3). The instrument calculates the results almost instantaneously. There is normally a facility for saving at least ten calculated conditions in the memory, and more modern machines can save more than 100 conditions.

Shear forces and bending moments, when displayed, are usually expressed as a percentage of the maximum permitted values as well as tonnes and tonnes/metres (or kN and kNm), as they would be if calculated manually.

Care of computerised loadicators and loading computers: When not in use the instrument should be switched off and covered over to protect it from dust. The data in the memory (hard disc) will be retained even though the power is switched off. The cooling fan, usually situated at the back of the instrument, must be left clear.

If the ship's stability and stress programme is on a computer floppy disc, a master copy of the disc should be kept by the shipmaster in a safe place. The working copy should be treated with care and protected from abrasion, dirt, heat and sunlight. The computer printer should be kept in good working order and new printer ribbons should be kept in stock. If the loadicator or loading computer breaks down this should be immediately reported to owners, and its repair should be treated as a matter of urgency.

Approved stability booklet and loading manual-the essentials: The ship's stability information is provided in one or several booklets, often running to more than 200 A4 pages. These approved stability booklet and loading manuals, which are referred to hereafter as loading manuals, are usually prepared by the shipbuilder and stamped with a seal of approval by a classification society or flag State national authority. In addition to at least one volume containing general stability information, examples of loading calculations and details of standard loadings, there may be additional volumes dealing with such subjects as grain and timber loading. One full set of loading manuals is likely to be securely fastened with permanent rivets or with seals to prevent the removal or addition of pages, and should be kept by the master for production to the authorities when required.

The chief officer should be provided with a second full set of loading manuals, in good condition as a working set and, since this set will inevitably become dog-eared and dirty with frequent handling over a period of years, a third set should be available in the company head office to photocopy when a replacement set is required aboard ship.

The *Instructions to Masters* and the *Notes for Guidance* which the loading manuals contain should be available to the master and his officers in a clearly written form in a language with which they are familiar. Included with the documents should be blank copies of the stability and stress calculation forms for use in making longhand stability and stress calculations.

Loading manuals

Use of loading manuals: When using the working copy of the loading manual for the first time after joining the ship, the following checks are recommended.

- Confirm that the master copy has been stamped by the current classification society and/or national administration and that the information is 'final' and not 'provisional'.
- Look for any indications that the manual under inspection to only part of the full stability information. For example, a note on the cover might read 'Vol.1 of 3' to show that the full information was contained in three volumes. Bring together the full set of loading manuals.
- Ensure that the working copy is complete with no pages missing and that its contents are the same as those of the master copy.
- Inspect the manual carefully from cover to cover for any restrictions on loading. Instructions similar to those quoted hereunder, but varying from ship to ship, may be found anywhere in the manual:
  - * The draft forward in rough sea should not be less than 7.32 m (24 ft) when slamming is expected. *(Seven-hold Panamax vessel)*
  - * Cargo holds Nos. 4 and 5 are permitted to be used as ballast tanks under either full or empty conditions during the ballast voyage. The holds have sufficient strength for a temporary partial filling between 20 per cent and 90 per cent only when weather conditions are fair and heavy rolling is avoided. *(Seven-hold Panamax vessel)*
  - * For short-range coastal voyages, No.3 hold need not be ballasted, but propeller must be 100 per cent immersed and shaft revolutions must not exceed 89 rpm. *(Five-hold handy-sized vessel).*
  - * Allowable values for shearing forces and bending moments are . . . etc.
  - * Maximum permitted uniform loads on tank top, decks and hatch covers are . . . etc. *(Handy-sized vessel)*
  - * Where cargo is loaded and unloaded in two ports, it is preferable to load cargo in Nos. 2 and 4 holds at the first loading port and to discharge from Nos. 1, 3 & 5 holds at the first unloading port. If it is required to load cargo first in Nos. 1, 3 & 5 holds, or discharge first from Nos. 2 & 4 holds, No. 3 double-bottom tanks must be filled to reduce the excess hogging moment. *(Five-hold handy-sized vessel)*
  - * When ship is fully ballasted with No.6 hold filled, No.4 topside tanks (adjacent to No.6 hold) must be empty. *(Nine-hold Cape-sized vessel)*

Deficiencies of loading manuals: The loading manuals supplied to most ships are, unfortunately, not user friendly. Many of them are bound in a manner which causes them to close unless they are being held open. This method of binding may be an efficient way to prevent the removal of pages, but it makes the manuals very difficult to use as working documents. The quality of the English used in manuals is often very poor, stumbling and inaccurate. Text which is difficult for a native English speaker to understand must be even more difficult for someone who speaks English only as a foreign language.

Essential instructions about the ways in which the ship is not to be loaded are often not given sufficient emphasis. All restrictions upon the way the ship can be loaded should appear prominently at the front of the manual. They should not appear as item 28 in a contents list of 52 items, appearing on page 176 of the manual, as was found in one loading manual/

Since loading manuals are produced by naval architects in many countries and each one is approved by one of many classification societies, it is perhaps not surprising that their contents are not standardised. It is, however, a cause for regret that they differ so widely in the layouts adopted and the expressions used. There are great differences, too, in the amount of data presented, and the manner of their presentation, with one loading manual adopting tabular presentation and the next graphical display for the same data.

These differences and deficiencies create unnecessary difficulties for ships' personnel who require to use the loading manuals and, despite the introduction of loading computers, a requirement to use the manuals will continue on ships which have not been provided with computers. A survey conducted by the Australian authorities in 1991[182] found 11 per cent of bulkers which responded did not use loading computers. The loading manual will continue to be needed by officers who prefer to use traditional methods or who have not learned to use the loading computer and it will be needed when the computer has broken down. Finally, it is important that officers can study the manual for an overall appreciation of the loading processes and for consideration of any special cases which may be presented.

Contents of loading manuals

Although the titles given to the graphs and tables will vary from manual to manual the information discussed below is to be found in most-perhaps even all-loading manuals. The basic information which the manual contains (and its purpose) is described. The commentary draws attention to common problems and is intended to help readers to use a loading manual.

Ships's principal particulars: These may be accompanied by a copy of the general arrangement plan, or the capacity plan. This information is for general reference and can usually also be found elsewhere.

Abbreviations used in this manual: This list, of which five examples are summarised in Appendix 10.1 is important since different manuals use a wide variety of different abbreviations which may be unknown to the user, and it is often difficult to guess the meaning of a particular abbreviation. Unfortunately, these lists are often incomplete.

Capacity tables for tanks and holds: These tables (Appendix 1.4) list the cubic capacity of every hold and tank and the position of its centre of gravity. The weight of the normal contents (fresh water, salt water, fuel oil, etc.) of the tank when full is also given. This information can be useful when listing weights and levers for trim and stability calculations, but the position of the centre of gravity must be corrected if the compartment is not full, and the weight of the contents must be corrected if the specific gravity of the contents is other than that assumed in the table.

Draft correction due to trim: The ship's stability data are compiled on the basis that the draft measurements are taken at the forward and after perpendiculars, and exactly amidships. In practice the draft marks are often not marked in these positions. When the ship has a trim the readings must be corrected to obtain the values at the perpendiculars and amidships, and an explanation of the correction is normally provided. (Fig. 10.4)

Worked example for displacement calculations: The displacement calculation (Appendix 10.X.I) starts with the drafts as read and corrects them for trim and deflection of the hull to give the mean of mean drafts. The displacement which corresponds to the mean of mean drafts is read from the hydrostatic tables. The displacement is corrected for any list, for first and second trim corrections (layer correction and form correction), and for density of the water in which the ship is floating. (These corrections, for which tables may be provided in the loading manual, are described in greater detail in Chapter 13.)

Hydrostatic tables: These tables (Fig. 10.5) provide values for each item of the ship's hydrostatic data for the full range of possible mean drafts. Hydrostatic tables normally show displacement in salt water of specific gravity 1.025, but occasionally other values (for example, 35 cubic ft/long ton = 1.02518) are used. The tables should be carefully inspected to confirm, if possible, that the SG used is 1.025 and to note whether weights are given in long tons or metric tonnes.

Worked example of trim and stability calculation: The basic trim and stability calculation, to calculate how the ship will be trimmed and the value of her fluid metacentric height (GoM) when certain weights have been loaded, is familiar to most seafarers and each case is normally shown on a single page in the loading manual. The calculation is shown in Appendix 10.X.2. All the intended weights for cargo and bunkers, etc., are entered along with the ship's lightweight, as are the vertical (VCG) and longitudinal (LCG) positions of their centres of gravity, measured upwards from the keel and horizontally from a reference point which is usually amidships, but occasionally the after perpendicular (AP).

The values of LCGs are measured either forward or aft from the reference point, forward measurements being distinguished from aft measurements either by entering them in separate columns or by giving them different signs. The sign convention used-(-) sign shows forward from the reference point and trim by the head, and (+) sign shows aft from the reference point and trim by the stern-is reversed in some loading manuals, so it is always necessary to be sure which convention is adopted in the manual in use.

Values for the LCG and VCG can be taken from the capacity tables for tanks and holds, but it may be necessary to use corrected values. (See below under 'CGs of part-filled compartments'.)

Free surface moments (inertia moments, moments of inertia, I or i) must also be entered in respect of any part-filled tanks. These data may appear in special tables of free surface moments (Appendix 10.6), or may be included in the information provided for each tank, either in the loading manual or the tank calibration tables. (See below under 'Free surface moments'.)

When weights, CGs and free surface moments have been entered in the trim calculation sheet, the vertical moments (product of weight and VCG) and longitudinal moments (product of weight and LCG) must be calculated and entered and the columns must be summed to provide total weights (the displacement), total vertical moments, total longitudinal moments and total free surface moments. From these the values of VCG, LCG for the loaded vessel and virtual rise of the centre of gravity due to free surface (GGo) are calculated by dividing each of the moments by the displacement.

Draft, moment to change trim 1 cm (MTC), position of longitudinal centre of buoyancy (LCB), position of longitudinal centre of flotation (LFC) and transverse metacentric height (TKM), all corresponding to the calculated displacement, are to be obtained from the hydrostatic tables. With this information the trim and the forward and after drafts are calculated.GGo is used to amend the VCG to obtain GoM, the fluid metacentric height. (For the detailed working of a trim and stability calculation see Appendix 10.X.2.)

Worked example of construction and use of the statical stability curve: The ability of a ship to return to the upright when inclined by an external force is of considerable importance. It is this which governs the ship's capacity to avoid capsizing in adverse swell and weather. The ship's statical stability curve (the GZ or righting lever curve) provides a measure of the ship's range of stability, (the range of heel over which she will return to the upright when inclined), and of her stability characteristics.

The International Load Line Convention, 1966, Regulation 10, Para.2, requires the master of every ship to be provided with sufficient stability information to ensure that the ship remains stable

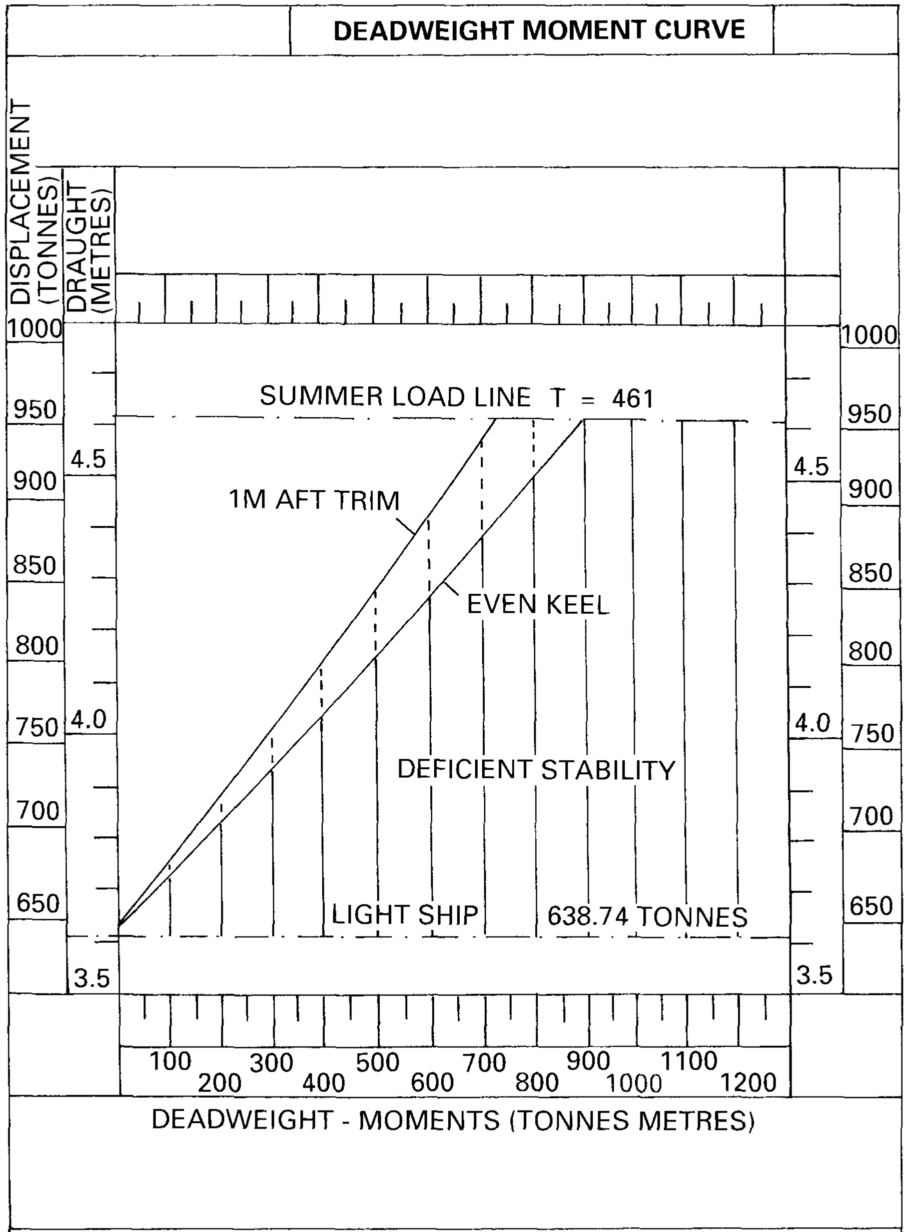


FIG.10.8

MAXIMUM PERMISSIBLE KG° CURVE

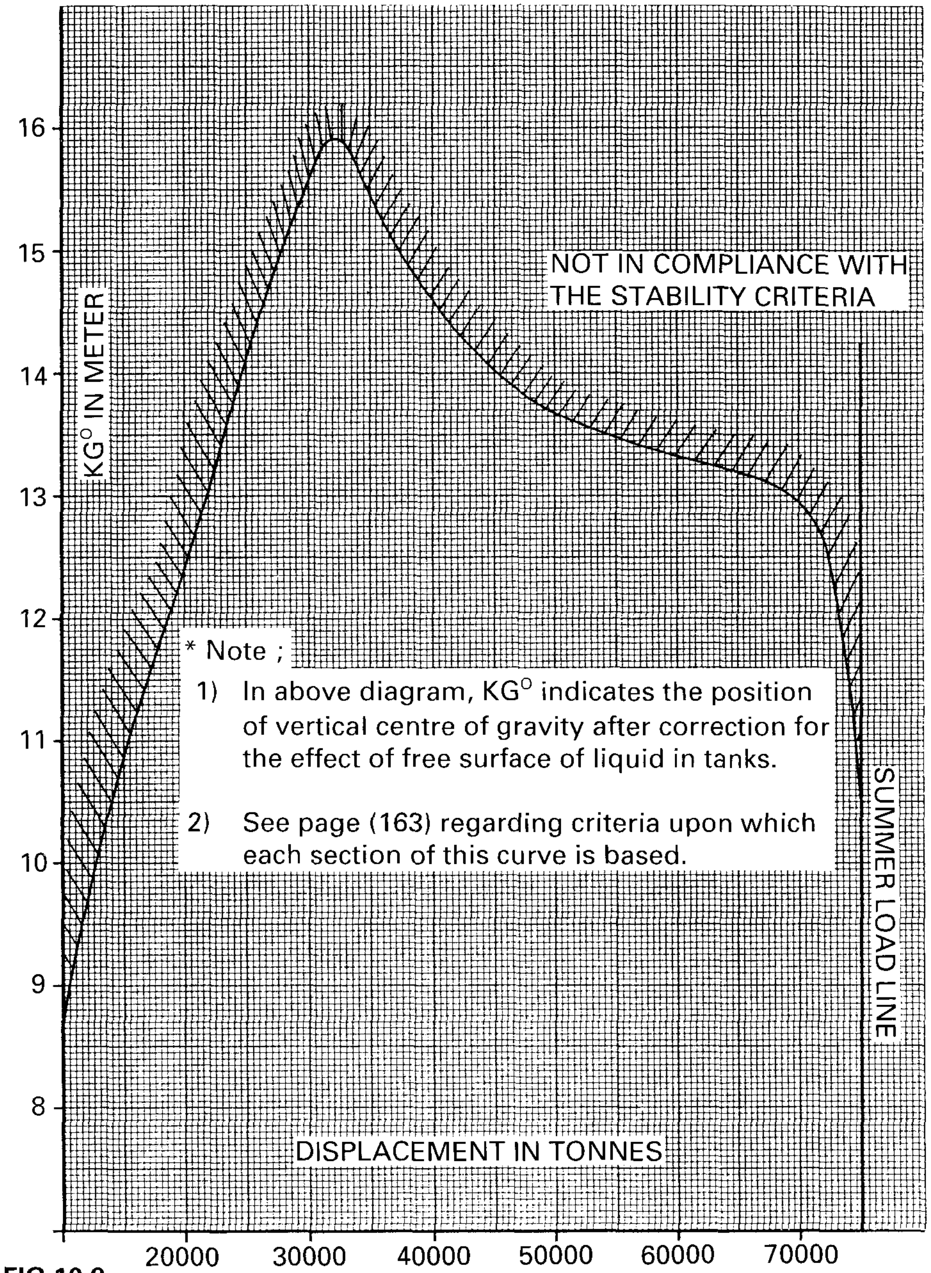


FIG 10.9

under varying conditions of service. Under this regulation, maritime administrations specify[44] minimum stability criteria which all ships must meet, in any sailing condition (Appendix 10.7). Most of these criteria are measured from the statical stability curve, so the curve must be constructed, measurements must be taken and calculations completed in respect of each critical stage of the voyage.

This process, fully described in Appendix 10.X.3, is a complex and tedious one which is seldom clearly described in loading manuals. When there is no alternative the longhand calculations must be undertaken for the worst condition of each voyage. The worst condition of the voyage is, of course, the condition in which the ship possesses the least positive stability. When a single cargo for one-port loading and discharge is carried, the worst condition usually occurs upon arrival in the discharging port or upon arrival in a bunkering port before discharge. However, a number of other factors such as the distribution of part cargoes and free surface effects in bunker or ballast tanks can create worst conditions at other stages, and it is prudent to check the stability for all departures and arrivals and for intermediate conditions when stability is small.

Simplified stability information: As already stated, the construction of the statical stability curve and the completion of the associated calculations are complicated procedures. Aboard ships which are suitably equipped, the process can be avoided by using a loading computer. Alternatively, simplified stability information has been included within the loading manuals of some newer ships and this information (when properly presented) provides a comparatively quick and easy method of finding if a particular loading will satisfy the minimum stability criteria.

The simplified stability information may be presented as a diagram or as a table in one of several different ways, of which three are mentioned here.

Maximum 'deadweight moment': An example of a diagram used for this method is attached (Fig. 10.8). Using the arguments *Displacement* or *Draft* on the vertical axis and *Deadweight moments* on the horizontal axis, a position is plotted. The deadweight moments required for this plot are the total vertical moments, including the free surface moments. The diagram shows a sector in which the stability is deficient or unacceptable, with the boundary of this sector varying according to the vessel's trim. Inspection of the diagram shows whether the plotted position in any particular case falls within the deficient stability sector. If the plot shows that the stability is deficient, the minimum criteria have not been satisfied and the ship must not go to sea or be at sea in the condition examined.

Maximum permissible KG: An example of a diagram used for this method is attached (Fig. 10.9), the vessel in question being a Panamax bulk carrier. British shipping industry sources are reported[40] to prefer this approach, using maximum permissible KG with a graphical presentation. The diagram is entered with arguments KG (corrected for free surface effect) and displacement, and the stability is acceptable provided that the plotted point does not fall in the area marked 'Not in compliance with the stability criteria'. One limitation of the diagram shown (Fig. 10.9) is that it stops at the Summer Load Line. Bulk carriers frequently load to tropical marks in West African, Indian, South American and North Australian ports and could not use this diagram to check their departure stability.

Minimum permissible GM: This simplified method, of which no example is provided, is similar in its general approach to the two methods described above, but plots the value of GM.

Simplified stability information like the three methods listed above has been provided in some loading manuals since the 1980s or even earlier, but its purpose has seldom been clearly explained. When well designed, the simplified stability information provides a quick means of ensuring that the minimum stability criteria are satisfied, as required by international regulations. Such diagrams or tables, if provided, should be found and used. Where the information is poorly presented, as is too often the case, owners and builders should be informed so that improvements can be achieved in the future.

Longitudinal strength: For many small and handy-sized bulk carriers the calculations already listed-namely, the calculation of draft, trim and stability-complete the basic calculations required. For larger bulk carriers and for those strengthened for loading in alternate holds there is, in addition, a requirement to calculate the longitudinal shear forces and bending moments in order to ensure that the maximum permitted values stated by the classification society are not exceeded. For such vessels the loading manuals will contain appropriate data, which are discussed below.

Longitudinal strength calculations

Nature of longitudinal stresses: Longitudinal shear forces are forces which tend to break or shear the ship across. Longitudinal bending moments are those moments which tend to bend a ship along her length, causing her to hog or sag. Both are a consequence of the irregular way that the hull weight, cargo and buoyancy are distributed along the length of the ship (Fig. 10.10).

Values to be calculated: Values for shear forces and bending moments are normally calculated at the positions of the ship's transverse watertight bulkheads, although computerised calculations often consider a larger number of stations. The shear force acting at a bulkhead (or other station) is the algebraic sum of the loads acting on either side of the bulkhead, whilst the bending moment acting at a bulkhead is the algebraic sum of the moments acting on either side of the bulkhead.

When a ship is in equilibrium in still water, values of shear force (SF) and bending moments (BM) at a specified bulkhead can be expressed as follows:

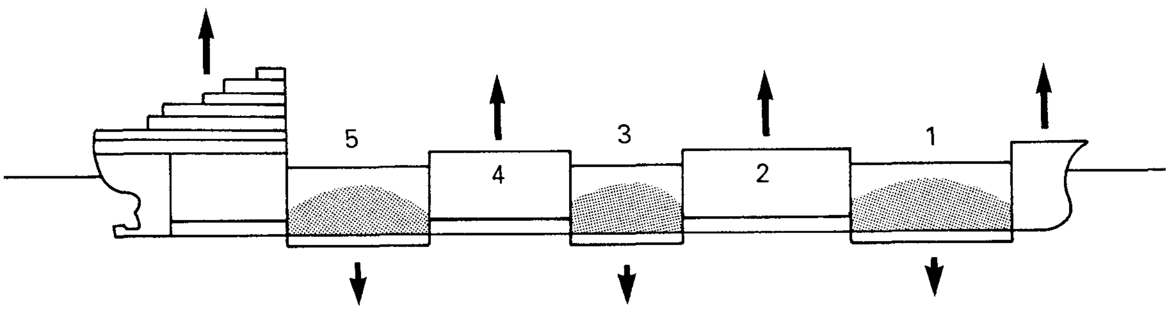
$$SF = W1 + W2 - W3$$
$$BM = M1 + M2 - M3$$

where

W1 = the constant lightship weight abaft the specified bulkhead, in tonnes

W2 = the deadweight carried abaft the specified bulkhead, in tonnes

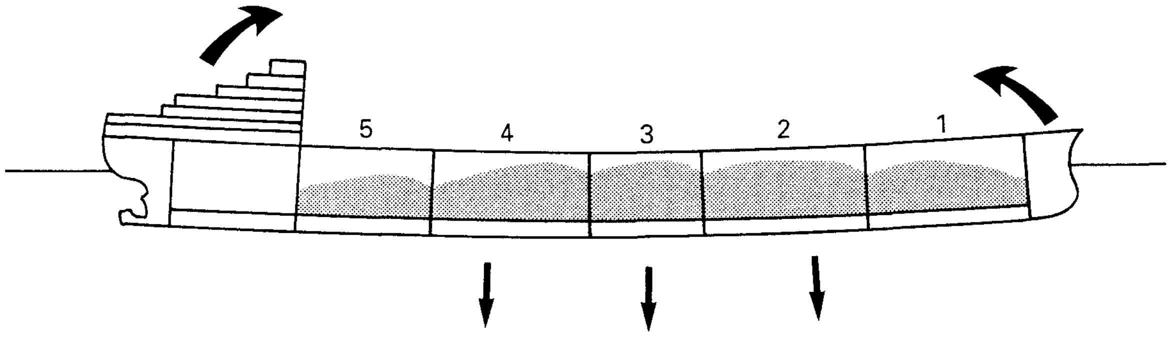
SHEAR FORCES & BENDING MOMENTS



Shear Forces are those forces which tend to break or shear the vessel across.

The vessel is exposed to forces due to the weight of the structure, the weight of the cargo, the forces of buoyancy, and direct hydrostatic pressure. When these forces are not in balance at every point along the length of the vessel shear forces will exist.

Shear forces are normally expressed in tonnes.



Bending Moments are those moments which tend to bend a vessel along its length, causing it to hog or sag. The bending moment at any point along the length of the vessel is equal to the algebraic sum of the moments of all loads acting between that point and one end of the vessel.

Bending moments are normally expressed in tonnes-metres.

FIG 10.10

W3 = the buoyancy acting abaft the specified bulkhead, in tonnes
Ml = the moment of Wl about the specified bulkhead, in tonnes.metres
M2 = the moment of W2 about the specified bulkhead, in tonnes.metres
M3 = the moment of W3 about the specified bulkhead, in tonnes.metres.

Of the foregoing, Wl and Ml are constant values reflecting the ship's light weight and are contained in tables provided in the loading manual. W3 and M3, the values of buoyancy, depend upon draft and trim and must be extracted from tables provided in the loading manual. W2 and M2 depend upon the weights loaded and their positions. These values must be compiled and entered by the person making the calculation.

Simplified calculation of longitudinal strength: In the more user-friendly loading manuals, the corrections to SFs and BMs for lightweight and for buoyancy have been combined to produce two tables instead of four. When the tables are entered with bulkhead frame number, displacement and trim, it is possible to extract a single correction for the shear force and another for the bending moments.

These combined corrections are sometimes known as S-values. Some manuals divide all the values in this calculation by 1,000 at the start of the calculation, and multiply by 1,000 at the end, apparently to make the numbers more manageable. Whilst some loading manuals require the user to use the weights and moments *abaft* the specified bulkhead, others use the weights and moments *forward* of the bulkhead.

Procedure for the calculation of shear forces and bending moments: It is not possible to provide explanations for all the different methods found in loading manuals for the calculation of shear forces and bending moments. To illustrate one approach, a description of the process for the *Regina Oldendorff* is provided. Aboard other ships where the information in the loading manual is presented in a different manner, it may not be possible to use this method of calculation.

The procedure, summarised below, is fully explained in Appendix 10.X.4. First, appropriate values are entered in a calculation sheet. The sheet is divided into columns with a column for each of the ship's transverse bulkheads, which are identified by their respective frame numbers. All the weights abaft (i.e., aft of) each bulkhead must be listed and totalled. The moments of each of these weights must also be listed and totalled and for this the distance of the centre of gravity (CG) of each weight from the relevant bulkhead is required. This distance is obtained by comparing the distance of the CG and of the bulkhead from midships.

For example: all the holds and almost all the tanks are abaft the collision (forepeak) bulkhead; all loaded compartments except those forward of the collision bulkhead are listed in the column for the collision bulkhead (frame 219 on the *Regina Oldendorff*). Each of the weights is then also entered in each of the remaining columns if it is abaft the bulkhead under consideration. The No.l fresh water tank (FWT), for example, is located in the stern abaft every bulkhead in the ship, so a weight in the No.l FWT is listed in every column. A weight in No. 1 hold, on the other hand, is abaft only the bulkhead at frame 219 (the collision bulkhead) so it is listed only in that column. The result of this procedure is that a decreasing number of weights is listed in each column as one proceeds from collision bulkhead towards engineroom bulkhead. Very few weights are carried abaft the engineroom aft bulkhead (frame 12 on the *Regina Oldendorff*), so very few items are listed in Column 12.

The distance of each weight from the bulkhead must be recalculated for each column, since the weight is a different distance from each of the bulkheads considered. When the weights and moments in each column have been totalled, they must be adjusted in a series of steps which take account of the lightweight of the ship and its distribution, the vessel's buoyancy when even keel and its correction for trim, to produce the values of SF and BM at the bulkhead under consideration. For correct results in these as in other stability and stress calculations, the signs (+ or -) of the numbers used must be shown and used correctly in the calculations.

Bulkhead correction: When the values of the shear forces have been obtained from the above calculations they can be reduced by a correction known as the bulkhead correction. The correction allows for the fact that some of the load caused by cargo in adjacent holds is transferred to the transverse bulkhead through the double bottom structure instead of through the side shell plating. Because this is so the stress on the ship is reduced: the bulkhead correction is recognition of this fact. The correction is only significant when the ship is loaded in alternate holds. When she is loaded in all holds the correction will be small and will not be needed.

The value of the correction is calculated by comparing the shear force at a bulkhead with the shear forces at one of the adjacent bulkheads (Fig. 10.11), and then with the shear force at the other adjacent bulkhead. The difference obtained in each comparison is multiplied by a factor obtained from the loading manual, and the lesser of the two values so obtained is used to reduce the value of the calculated shear force. If the bulkhead correction is ignored, the longitudinal stresses appear to be greater than they really are, so the correction can safely be ignored if the stresses are within the permitted limits.

Calculated values of SF and BM: The purpose of calculating the values of SF and BM is to ensure that any proposed loading does not exceed the values specified by the classification society. The maximum permitted values are listed in the loading manual and should be shown prominently, though in practice they are sometimes difficult to find. Several sets of maximum permitted values may be stated for different conditions. For example, the permitted values are higher when the ship is in port than when she is at sea; they may be higher when the ship is loaded homogeneously than when she is jump loaded in alternate holds with a high-density cargo; and they may be higher when she is sagged than when she is hogged. If it is found that the proposed loading does exceed the maximum permitted values, it is unsafe

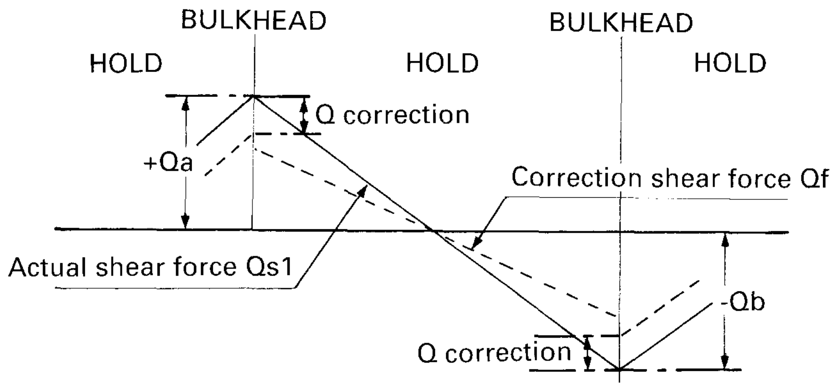
METHOD OF SHEAR FORCE CORRECTION USING THE BULKHEAD FACTOR (ACCORDING TO ABS RULES AND REGULATIONS 6-3-3-C)

1. THE SHEAR FORCE CORRECTION

Q CORRECTION = Q DIFFERENCE * BULKHEAD FACTOR

Q DIFFERENCE = THE NET BUOYANCE (OR LOAD) OF A HOLD, DERIVED FROM THE CHANGE IN SHEAR FORCES ALONG THE LENGTH OF THE HOLD.

HOLD NO.	BULKHEAD CORRECTION FACTOR
1	0.1311
2 THRU 6	0.2394
7	0.1891



WHEN Qa AND Qb ARE OF DIFFERENT SIGN

Q DIFFERENCE = Qa - (-Qb) = Qa + Qb

WHEN Qa AND Qb ARE OF THE SAME SIGN

Q DIFFERENCE = (Qa - Qb)

2. THE CORRECTED SHEAR FORCE : QF

Qf = Qsl - Q CORRECTION

* Qsl : THE ACTUAL SHEAR FORCE AT THE BULKHEAD UNDER CONSIDERATION

* Q CORRECTION TO BE USED IS THE LESSER OF THE VALUES DERIVED FOR ADJACENT HOLDS.

FIG. 10.11

EXAMPLE OF USE OF BULKHEAD CORRECTION FACTOR TO CORRECT THE SHEAR FORCE

Fr.	SHEAR FORCE				
Fr.	SHEAR FORCE ②				
BULK Fac1					
Fr.	SHEAR FORCE ①	④=①-② ⑤=①-③	⑥④×BULK Fac1 ⑦⑤×BULK Fac2	⑧=①-⑥ ⑨=①-⑦	⑩
BULK Fac2					
Fr.	SHEAR FORCE ③				
47	3870				3870
0.1891					
77	-234				-234
0.2394					
107	-2892				-2892
0.2394					
137	-5470	-2578 -9379	-617 -2245	-4853 -3225	-4853
0.2394					
167	3909				3909
0.2394					
197	1794				1794
0.2394					
227	-510				-510
0.1311					
258	-1716				-1716

①,②,③ : Actual shear force at each Fr.

④,⑤ : Shear force difference value

⑥,⑦ : Shear force correction value

⑩ : Corrected shear force (the greater of the value between ⑧ & ⑨

and cannot be used and an alternative distribution of weights will have to be tried.

SF and BM diagrams: When the values of shear forces (SF) and bending moments (BM) have been obtained a SF and BM diagram can be drawn. Whilst this is not essential to a safe loading, it will help to show the distribution of longitudinal stresses and irregularities in the diagram may draw attention to errors in the calculation.

In the diagram the shear force curve should be drawn by joining the calculated values with straight lines. The calculated values of bending moments should be joined by a fair curve. Peak and trough values of bending moments will occur in positions where the shear forces are zero. A typical diagram is at Fig. 10.12, whilst the diagram which accompanies the worked example at Appendix 10.X.4 draw attention to an interesting fact. When a bending moment curve is obtained by joining the values for BM at each bulkhead in a smooth curve, the curve does not appear to comply with the rules. It does not have peak or trough values in each position where the shear force curve is zero. The explanation for this is that, when additional values of BM are plotted between the bulkheads, it becomes clear that the BM curve is an undulating one with peak or trough values which coincide with the zero values of SF. It does not matter that the normal plot, taking values only at the bulkheads, does not detect the peaks and troughs. The classification society will have taken account of this when setting the limiting values at the bulkheads.

SF and BM diagrams produced by loadicator or computer (Appendix 10.3) may look rather different from hand-drawn diagrams which should look more like the example in Appendix 10.X.4. This is because the loading instrument may be used to calculate stress values at much more frequent intervals, thus producing a more complex curve.

SF and BM diagrams are usually plotted against scales which show actual values. Alternatively, it is possible to plot them as a percentage of the maximum permitted value, a method which provides a less cluttered graph (Appendix 10.X.4). Since different limiting values are provided for different conditions of loading, it is essential to specify the limits used.

Manual calculation of longitudinal stresses: Such methods as the foregoing are often optimistically described by those who produce loading manuals as 'simplified methods of calculation' or 'rapid and simple hand calculations' for longitudinal strength. In reality some of the systems presented are poorly constructed, complicated and difficult to follow. Even the best of them require the extraction from tables of a substantial number of figures which must then be entered on the calculation sheet along with a further large number of figures from other sources. Finally, to obtain the SFs and BMs, a large number of additions and subtractions must be made accurately. When this process has been completed, the stresses arising from a single distribution of weights have been calculated. The entire process must be repeated whenever the consequences of an alternative weight distribution are required.

The most successful way to approach this repetitive work is to extract and enter the data systematically, starting from the forward bulkhead and transferring data across the columns where possible. A blank form constructed on chartpaper with data entered in pencil may save time if the form when completed is then photocopied to preserve a record of the calculation. Thereafter the data which have changed can be erased and the form can be used again.

At its best the procedure is slow and cumbersome and it is most unlikely that it is always used, as it should be on ships without loading computers in working order, to verify that every stage in the proposed loading programme lies within safe limits.

Stability and stress calculations-options

Possible methods of calculation: There is a requirement, described above, for a number of calculations to be made to establish the ship's draft, trim, stability and longitudinal stress values for successive steps during the loading and during the voyage. The calculations may be done on a computer or loadicator or with pencil and paper, although if there is no dedicated computer with specialist software many of the necessary calculations can still be done by computer or calculator.

Calculations by computer or loadicator: Calculations by computer or loadicator use software which is tailor-made for the ship on which it is being used, with the ship's dimensions and hydrostatic data already entered. Such calculations are quick and easy when compared with the alternatives, but they still call for the accurate keying in of all the weights loaded and discharged at every stage in the loading and the voyage.

For most ships the software provided for stability and stress calculation has been designed to show the final condition before sailing, using a layout similar to that used for the standard conditions in the ship's loading manual. This makes it possible to confirm that the ship's condition is satisfactory before she puts to sea. This calculation can be repeated for each stage in the loading, giving results suitable for insertion into The Nautical Institute's Cargo Operations Control Form.

Regrettably, most software packages do not provide a printout which summarises on a single sheet all the steps in a loading/deballasting or discharging/ballasting programme. Packages which make it easy for the master to check that every stage in the loading or discharging programme is safe are now on the market and although not yet widely used are to be welcomed. The programme marketed by Shipwrite-Marine Computer Systems, for example, is designed to give immediate warning to the operator if he keys-in a weight which will cause longitudinal stresses in excess of allowable limits.

Longhand calculation: Calculations with pencil and paper are very time-consuming and for more difficult loadings many hours may be needed to complete them properly. To avoid error they should be completed in a standard format, using blank copies of the ship's trim and stability calculation form and shear force and bending moment form. Completed samples of these forms should be, and normally are, provided in the ship's loading manual. Blank forms should be available aboard; if they are not they must be made.

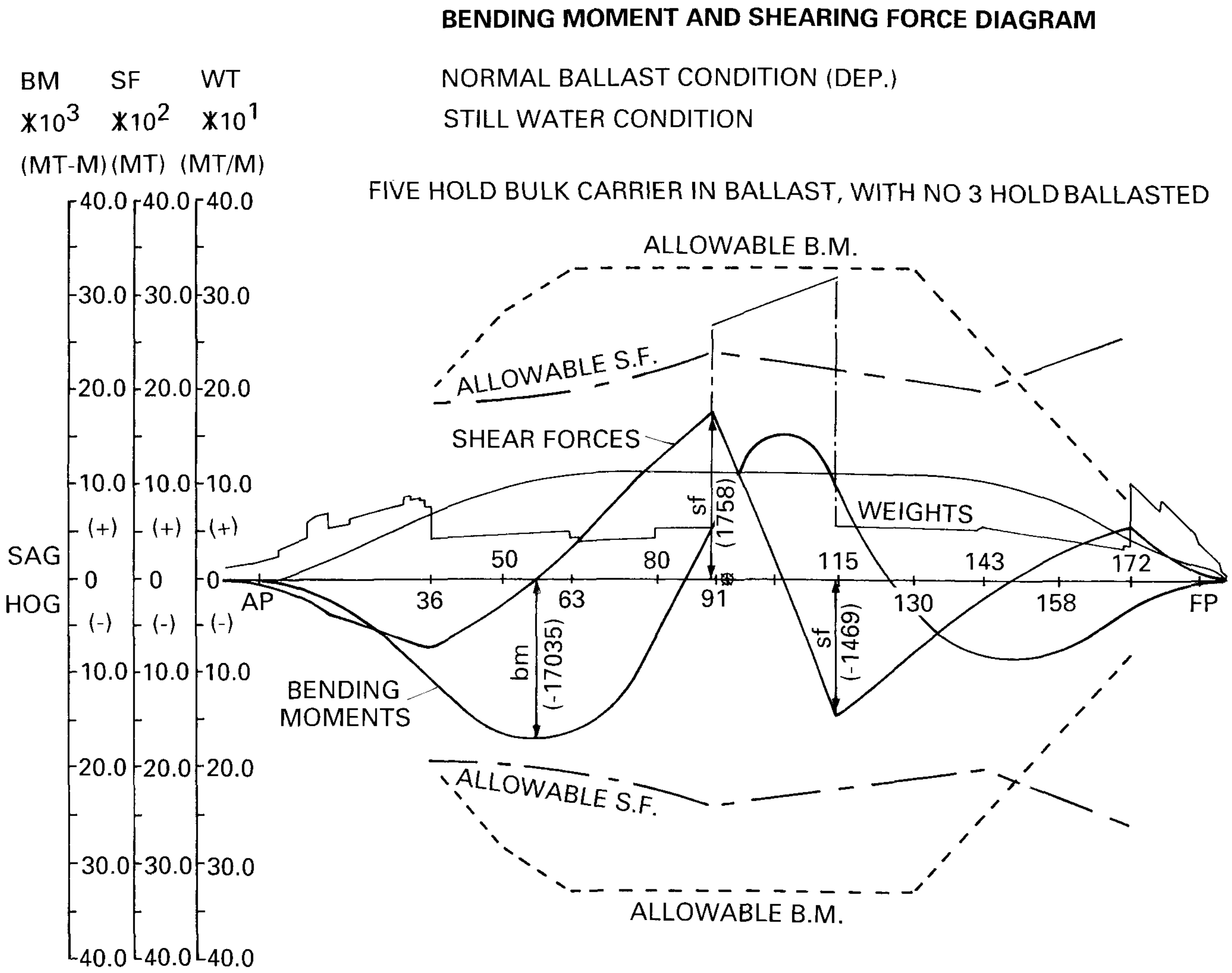

BENDING MOMENT AND SHEARING FORCE DIAGRAM
NORMAL BALLAST CONDITION (DEP.)
STILL WATER CONDITION
FIVE HOLD BULK CARRIER IN BALLAST, WITH NO 3 HOLD BALLASTED
BM ✱10^3 (MT-M)
SF ✱10^2 (MT)
WT ✱10^1 (MT/M)
40.0
30.0
20.0
10.0
(+)
SAG
0
HOG
(-)
ALLOWABLE B.M.
ALLOWABLE S.F.
SHEAR FORCES
WEIGHTS
BENDING MOMENTS
sf (1758)
sf (-1469)
bm (-17035)
AP
36
50
63
80
91
115
130
143
158
172
FP

FIG 10.12

Copies of the completed calculations should be retained and filed. They will be useful if similar cargoes are carried again and will provide evidence that the ship has been operating safely.

Stability calculation-practical considerations

Centres of gravity of full compartments: Positions of centres of gravity (CGs) for grain space and for bale space within the holds may be stated in the loading manual. Provided that compartments are full, the CGs for grain space should be used for all bulk cargoes except for unitised cargoes such as timber or woodpulp, for which the bale space CGs are appropriate.

Vertical CGs of part-filled compartments: When a compartment is only partly filled the position of the vertical centre of gravity (VCG) of its contents will be lowered. If the reduction in height of the centre of gravity is ignored in calculations the inaccuracy is a 'safe' one which makes the ship appear less stable than she really is. This error will have no effect upon the accuracy of the calculation of the ship's trim and longitudinal stresses and can be ignored provided that the calculations still show that the vessel has adequate stability. In cases in which the ship's positive stability is small, it will be necessary to take account of the actual height and distribution of each weight. This will lead to the use of an amended height of the VCG.

For bunker and ballast tanks and grain loaded holds, the position of the CG of the compartment when part filled may be provided in the form of a graph or table in the ship's loading manual or tank calibration tables. If not available from graph or table, it must be calculated or estimated using prudent approximations. For a VCG it is prudent to assume a position a little higher than its actual position. It is reckless to assume a VCG lower than its actual position.

Longitudinal CGs of part-filled compartments: The position of the LCG of a ship's tank can be accurately predicted since it depends upon the geometry of the tank and the volume of liquid it contains, adjusted slightly to take account of any trim or list. The position of the LCG of a hold containing a quantity of bulk cargo cannot be predicted with equal accuracy, except when the cargo is trimmed reasonably level to the boundaries of the space as required by the *EC Code*[22]. In practice, the cargo is frequently peaked and it is impossible to position a pile of bulk cargo in a hold with absolute accuracy. This has several practical implications for those planning the loading of dry bulk cargoes.

The port and starboard sides of each hatch coaming of some bulk carriers are paintmarked with conspicuous marks with which the loading spout is to be aligned. This practice is used particularly aboard small bulkers with long holds, where several pouring positions in each hold are often used. This is no more than an approximate method of positioning a large tonnage of bulk cargo in the hold, but if the same paintmarked points are used voyage after voyage, the ship will be able to place some reliance upon the trim that is calculated on the basis of the planned cargo distribution. When required, it is possible to change the positioning of the cargo within the hold to some extent by directing the loading spout to pour in a position x metres forward or abaft the paintmarked position.

Whatever point of loading is chosen, it is not possible to guarantee that the cargo will be distributed around that point in an absolutely regular manner, since the distribution will be influenced by the shape of the hold, the trim of the ship and the change of trim whilst the cargo is being loaded, in addition to the accuracy of the method of pouring adopted by the loading foreman. As a result, the eventual LCG of the cargo in the hold is unlikely to be exactly that which was planned. The trimming pour (described in Chapter 9) is used to correct the trim as necessary, but this does not alter the fact that even if the correct tonnage is loaded into each hold it is unlikely that its longitudinal distribution will be exactly that assumed in calculations.

Free surface moments: Free surface moments (moments of inertia, measured in m*) represent the effect of a part-filled tank upon the ship's stability and must be included in the calculation for each tank which is part full. Many loading manuals simply record a maximum value for free surface moments (FSMs) for each tank and there is no alternative to using that figure. Whilst this is inaccurate, it is safe, as in most cases it will result in an overestimate of the loss of stability. The most comprehensive loading manuals, however, provide a graph of values for free surface moments for each tank and the appropriate value to match the tank sounding can be extracted. For some ships the free surface moments are printed not in the loading manual, but in the tank calibration tables, where a full set of values corresponding to soundings is provided.

In a forepeak tank or topside tank the value of FSMs increases with the sounding (because the surface area of the ballast water increases), whilst the double bottom tanks which extend into the lower hopper sides have FSMs which fall to zero as the liquid level rises to the top of the hopper side.

Free surface moments vary according to the specific gravity of the liquid. In some loading manuals the FSMs have been corrected by multiplying them by suitable values of specific gravity such as 1.025 for water ballast, 1.00 for fresh water, 0.98 for fuel oil and 0.85 for diesel oil. In cases where they have not been corrected appropriate corrections should be applied, though their values will usually be small.

Grain stability

When it is intended to carry a cargo of grain, the master must first satisfy himself that the ship is able to comply with the requirements of the IMO Grain Rules at all stages of the voyage. (See Chapter 19.) They include the requirement to ensure that the vessel can maintain sufficient stability throughout the voyage to satisfy the stringent demands of the Grain Rules.

Fig. 10.13 is a flow chart which shows the sequence of calculations which must be undertaken. These calculations are the same as those required to complete the grain stability calculation forms issued by various national authorities (described and illustrated in

FLOW CHART OF GRAIN STABILITY CALCULATION

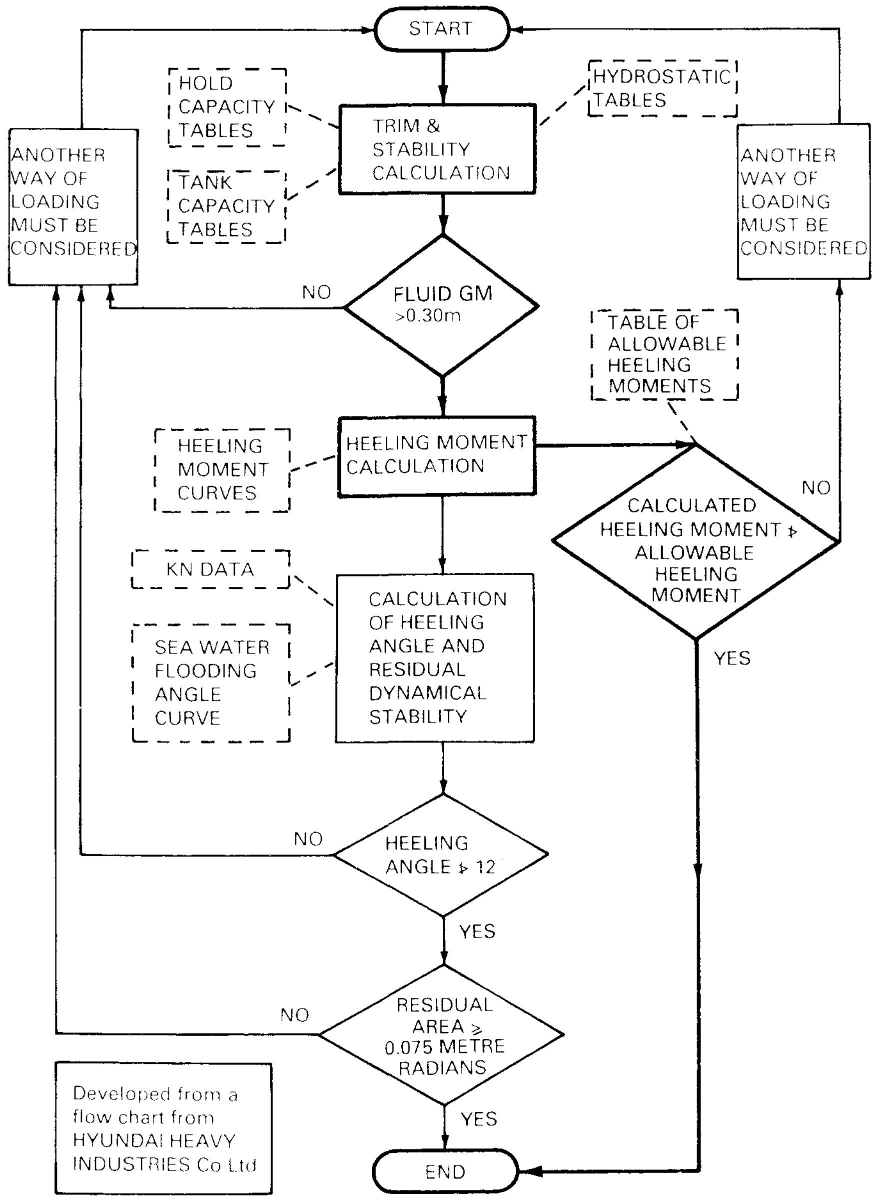


FIG 10.13

FLOW CHART OF TIMBER STABILITY CALCULATION

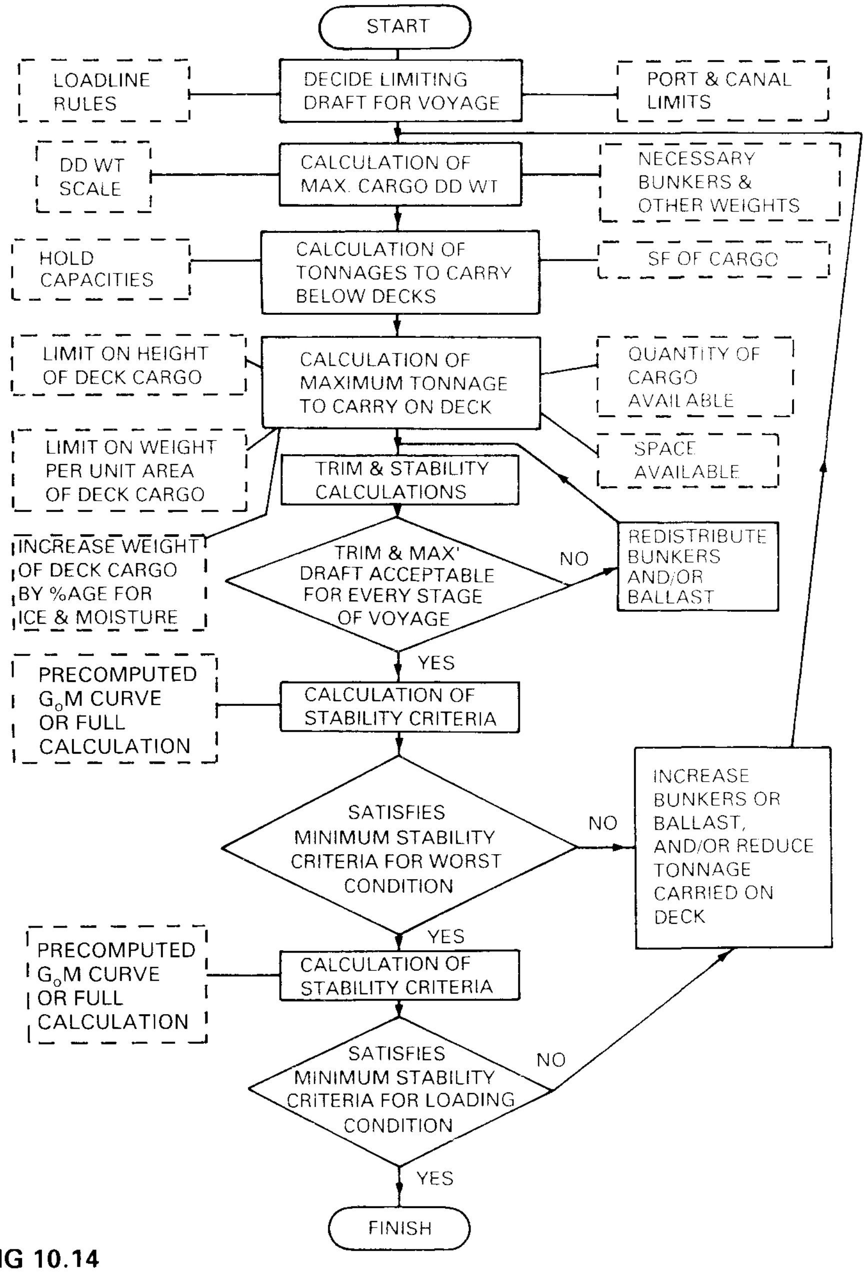


FIG 10.14

Chapter 19). Appendix 10.X.5 contains a worked example for the *Regina Oldendorff.* This is from the same voyage with grain from Three Rivers to Oran as has been used to illustrate the computer printout and the grain stability forms.

The detailed steps in the calculation of grain stability can be followed in the worked example. For those who require a reminder of the objects of the calculation the process is summarised in the flow chart and is explained below.

Grain stability calculations will be required for a number of different events during a grain voyage to ensure that the vessel remains stable throughout. A calculation must be completed for departure from the loading port and for arrival at the discharging port. Calculations must also be made for arrival at and departure from any bunkering port and for the worst condition of the voyage. The worst condition normally occurs immediately before arrival at the discharging port, when bunkers are at their lowest level. However, the occurrence of large free surface effects in bunker tanks or the taking of bunkers could mean that the worst condition occurs at some other point in the voyage, and this possibility must be kept in mind.

After loading grain in Three Rivers, the *Regina Oldendorff* was to cross the Atlantic to the Straits of Gibraltar. She was to bunker at Ceuta and then proceed the short distance to Oran. Bunkering at Ceuta would improve the vessel's stability by placing weight in the bunker tanks, situated low in the ship. Thus the worst stability condition would occur on arrival at Ceuta, before bunkering. This is the condition used in the calculation in Appendix 10.X.6. The procedure for the calculation is as follows.

Complete a normal trim and stability calculation of the kind shown in Appendix 10.X.2. When the hold ends are untrimmed the hold capacity is reduced. This reduced capacity, which is shown in the loading manual, must be used to calculate the tonnage which each compartment can contain and the stowage factor.

Is the fluid GoM **less than 0.3 metres?** If the calculations show that the fluid metacentric height (GoM) in the worst condition is less than 0.3 metres the intended loading does not comply with the Grain Rules, and calculations must be restarted with an alternative cargo distribution. Provided that the fluid GM in the worst condition is more than 0.3 metres, proceed to the next step.

Obtain corrected volumetric heeling moments (VHMs) for each cargo space: The heeling moments (sometimes called the shifting moments or upsetting moments) for each cargo space are obtained from tables or graphs in the loading manual. Appendix 10.X.7 contains a full explanation of the corrections to heeling moments, and Appendix 10.X.6 illustrates how the values were obtained for use in Appendix 10.X.5. The procedure is complicated as the correct tables must be used, and corrections must be applied as necessary to take account of the following considerations:

- Have ends been trimmed?
- Have volumetric or true centres been assumed for cargo?
- Is compartment full or part filled?
- Was ullage of cargo calculated or measured?
- What corrections have been included in tables?

Correct VHMs to obtain grain heeling moment: All VHMs must be corrected for the density of the cargo, according to the following formula: actual grain heeling moment = VHMs x density. An alternative way of making this correction is to divide the VHMs by the stowage factor of the cargo.

Whichever method of calculation is used the units used must be consistent. If the VHMs are expressed in m^4 they must be amended by the density in tonnes/m^3 or stowage factor in m^3/tonne (and not in tons/ft^3 or ft^3/ton). Actual grain heeling moment = VHMs/ stowage factor.

Calculation of permissible grain heeling moments: Permissible (or allowable) grain heeling moments for any condition of loading must be read from the ship's loading manual from a table which is entered with a displacement and fluid vertical centre of gravity (fluid KG). An accurate result must be obtained by interpolation between the values given.

Comparison of actual and permissible grain heeling moments: Provided that the actual corrected grain heeling moments are less than the permissible (allowable) grain heeling moments, the ship when loaded in the manner proposed complies with the stability requirements of the Grain Rules. If the actual moments are more than the permissible moments, an alternative loading plan must be devised and the calculations repeated.

Reduced values of VHMs can be achieved by rearranging the cargo in any of the following ways: reduce the number of holds which are part-filled; use a smaller capacity hold as the part-filled hold; change the level of cargo in the part-filled hold to avoid the half-filled condition where VHMs are greatest; trim hold ends; and if topside tanks are designed for grain, consider using some of them. Alternatively, a greater KG and larger values of permissible heeling moments can be achieved by a better distribution of bunkers and ballast in the ship.

Monitor the density/stowage factor of the grain cargo during loading: The preloading calculations for a grain cargo depend upon an assumed figure for stowage factor or density for the cargo. The figure is normally provided by shippers or loading stevedores. It may prove to be inaccurate for any of a number of reasons. The grain or the ship may not be typical or the information from the shippers may prove to be unreliable. If the figure proves to be wrong, the ship's actual VHMs and corrected grain heeling moments will be different from the figures calculated beforehand and the ship may not be safe to undertake the voyage.

Throughout loading, any opportunity should be taken to obtain an accurate measurement of the stowage factor and/or density of the cargo. Completion of loading of the first hold is an obvious opportunity to divide tonnage loaded by the volume of the hold in cubic metres to calculate the stowage factor. If the hold ends have not been trimmed, the hold volumes must be corrected for the voids in the untrimmed ends. If the stowage factor or density found is different to that used in preplanning the loading, the calculations must be reworked to ensure that the ship will still satisfy the stability requirements throughout the voyage.

Simplified stability calculation: The method of calculating grain stability by the use of actual and permissible grain heeling moments (described above) is a simplified method of stability calculation, and is the only calculation which needs to be completed aboard ships provided with tables of grain heeling moments.

Aboard a ship which is not provided with appropriate tables it is necessary to complete full stability calculations to measure in the statical stability diagram the net or residual area between the heeling arm curve and the righting arm curve up to the angle of heel of maximum difference between the ordinates of the two curves, or 40°, or the angle of flooding (6f)°, whichever is the least. In all conditions of loading this must not be less than 0.075 metre radians. In practice this calculation is seldom required, since most grain carrying vessels are provided with tables of permissible and volumetric heeling moments, and it has not been described in this book.

Timber stability

The carriage of timber cargoes is described in Chapter 19, and the operation of a log carrier is described in Chapter 18. These notes describe stability calculations for timber cargoes. The procedure is the same whether done by computer or by longhand calculation, though the latter process is much more time consuming.

Timber is a low-density cargo which fills the ship long before she is loaded to her marks. To increase the cargo lift, timber is usually carried on deck; but, as the height of the deck cargo rises, so the ship's positive stability is reduced. In cases where lack of stability prevents the vessel from carrying a full deck cargo the following steps must be taken to ensure that the maximum cargo is carried. They are depicted in the flow chart at Fig. 10.14, and a worked example of the planning of a timber loading is at Appendix 10.X.8. The main considerations when planning a timber loading are the following.

Identify the limiting point in the voyage in terms of draft following the procedure described in Chapter 9 and calculate the deadweight to correspond with the limiting draft.

Obtain the stowage factor of the cargo and use it to calculate the tonnage of cargo which can be accommodated in each hold: Where cargo of several different stowage factors is available the heaviest cargo should be carried as low as possible in the ship. (Timber does not normally stow between the frames and beams in the hold, so the weight in each hold should be considered to act at the CG of the bale space of that hold.)

From the calculated deadweight deduct bunkers, miscellaneous weights and the cargo to be carried in the holds: The remaining deadweight can be carried on deck, provided that there is sufficient space, and provided that sufficient positive stability can be maintained. These matters are examined below.

The space available on deck is limited by the available area of deck and hatch covers and by any restrictions upon the height of the stow. Permissible height of timber deck cargo is limited by the 1966 Loadline Convention to one-third the vessel's beam for vessels in seasonal winter zones and may be restricted at other times by the classification society. The maximum permitted loadings on deck and hatch covers are other matters which limit the height to which deck cargo can be carried. The final restriction upon height of deck cargo is that which ensures a good view from the bridge for navigational purposes. Taking account of all these considerations calculate the maximum height of cargo permitted.

Using the stowage factor of the timber and the height and area of the deck cargo, calculate the weight of the maximum amount of cargo for which there is room on deck. The total deck and hatch top areas may be stated in the loading manual or it may be necessary to calculate them. The necessary measurements can be readily obtained from the ship's capacity plan. It is prudent to check the result obtained: the total deck area available for cargo is likely to be 10-20 per cent less than the product of maindeck length and maximum beam. The stowage factor (SF) for timber on deck is usually slightly better than that for timber below decks, since no space is lost over deck cargo, as there is over cargo in the holds. For example, the loading manual for the *Regina Oldendorff* proposes an SF for timber below decks of 76 cuft/mt and a figure of 66 cuft/mt for timber on deck, whilst another loading manual suggests 82 cuft/mt below decks and 77 cuft/mt on deck. These figures will vary with the measurements of the timber, the configuration of the ship and the quality of the stevedoring, so can be no more than approximations.

Choose a height (KG) for the centre of gravity for the deck cargo. Where a full volume of deck cargo is being considered the KG given in the loading manual-for example, in an appropriate worked example of timber loading-can be used, although it should be checked for accuracy. When planning for less than a full volume of deck cargo the KG of the deck cargo must be reduced. As an approximate rule of thumb, a 1.0 metre reduction in the height of the deck cargo will lead to a 0.5 metre reduction in the KG of the deck cargo. Reductions of other amounts will be in the same proportion.

For calculation of the vessel's trim and stability at the end of the voyage, the calculated weight of the deck cargo must be increased (normally by 10 per cent) to allow for absorption of water from spray and rain during the voyage. If the additional weight due to absorption will overload the upper deck, the hatches or the ship then the tonnage of deck cargo must be proportionately reduced to prevent overloading. (The vessel's worst condition for stability purposes will normally occur at the end of the voyage, except when the vessel takes extra bunkers at an intermediate port, when worst conditions will occur at commencement of bunkering).

Weight of the deck cargo at the end of the voyage must also be increased to allow for ice accretion-the formation of ice on the deck cargo-where this is likely to occur. Guidelines vary considerably as to the figure to allow for ice accretion, with recommendations ranging from 2-10 per cent of weight of deck cargo. In high latitudes in winter the total allowance for absorption plus icing should lie within 12-20 per cent.

Excessive initial stability should be avoided as it will result in rapid and violent motion in heavy seas, which will impose large sliding and racking forces on the cargo, causing high stresses on the lashings. It is recommended'" that the metacentric height should not exceed 3 per cent of the vessel's breadth, so a ship with a beam of 22 m should have a fluid metacentric height no greater than 0.66 m. This will rarely be a problem as excessive stability seldom occurs on forest product ships.

Complete a set of trim and stability calculations and confirm that the vessel's draft, trim and fluid metacentric height (GM) **will be acceptable at every stage in the voyage.**

Check the vessel's stability at the worst condition she will experience during the voyage. If a criteria curve for fluid GM (GoM) for timber loading (Fig. 10.15) is provided, the master can confirm that the vessel complies simply by plotting the calculated GuM against displacement on the curve. If no such curve is provided the master must complete a full statical & dynamical stability calculation. (Appendix 10.X.3).

If the loading does not satisfy the vessel's stability criteria bunkers or ballast must be increased or tonnage of deck cargo must be reduced and stability must be rechecked. The first and cheapest option is to carry additional ballast and where possible this method will be used to improve stability. Bunker distribution will also be rearranged to minimise free surface effect in the worst condition. If the improvement achieved by ballast is insufficient there is the possibility of carrying additional bunkers. This has a cost, since bunkers must be purchased earlier than would otherwise be required and possibly at a higher price.

If stability is still inadequate when all possible has been done with ballast and bunkers, the tonnage of deck cargo must be reduced. This is best done by reducing the height of the deck cargo overall by removing a layer of the planned deck cargo from the top of the stow. Alternatively, it can be achieved by stepping the cargo down at one end of the stow. The creation of vertical faces of cargo in the stow which could present a barrier to seas sweeping the decks should be avoided.

Check the vessel's stability for the commencement of the voyage using a GoM criteria curve or a full calculation of all the stability criteria, as before. When a satisfactory worst condition has been devised, it is possible to work back to the initial condition on departure from the loading port. This condition must be checked to ensure that it satisfies the stability criteria and any draft requirements. In the initial condition the GoM for most vessels must be at least 0.1 metres. It is not necessary to assume any water absorption or icing in this condition.

Check the arrival condition at the discharge port, if that is different from the worst condition, and check any other intermediate stages to ensure that all comply with the stability criteria, and with draft requirements.

The illustration of the planning of a timber voyage (Appendix 10.X.8) uses an imaginary voyage of the *Regina Oldendorff* from Umea, a Swedish port in the north Baltic, to Alexandria, Egypt, by way of the Kiel Canal. This provides an opportunity to consider the issues which can arise with timber cargoes, including the need to shut out some deck cargo in order to achieve adequate stability.

Sources

18. *Code of Safe Practice for Ships Carrying Timber Deck Cargoes.* International Maritime Organization. 1991.

40. UK Department of Transport Merchant Shipping-Notice No. M. 1122. February 1984.

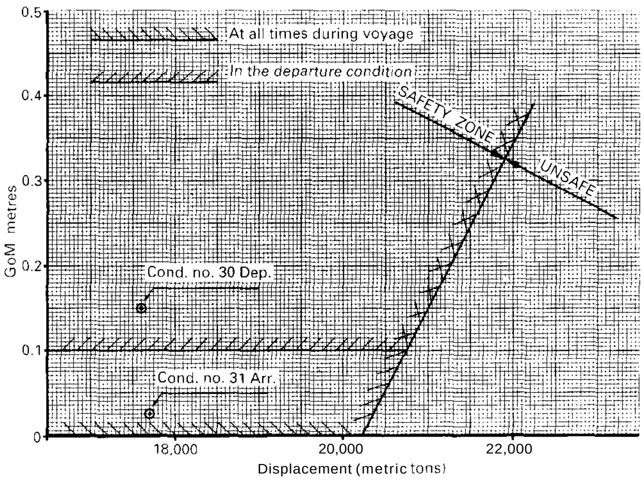
44. Stability Information Booklet. L'K Department of Trade & Industry. 1973

46. *IMO Grain Rules* International Maritime Organization. 1982.

182. *Pilot Study into Loading of Bulk Carriers.* Report from Australia to IMO Maritime Safety Committee. MSC 60/20/5.

(Blank Displacement, Trim, Stability, and Shear Force and Bending Moments calculation forms are available from The Nautical Institute.)

3) GoM CRITERIA CURVE FOR TIMBER LOADING



This curve shows the permissible minimum GoM for each displacement based on the stability criteria which is recommended by IMCO Resolution A.206

FIG 10.15

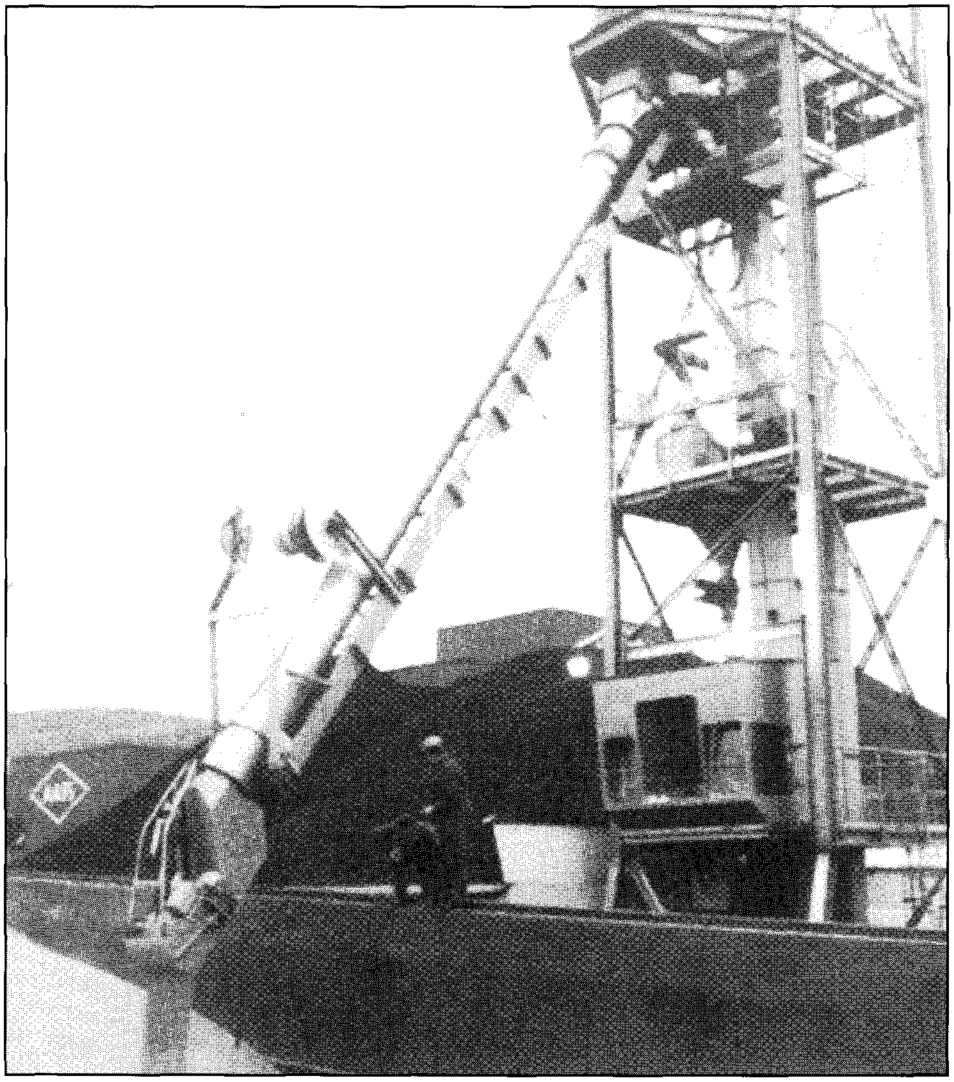


FIG 11.1 LOADING PIPE FROM SILO
(Courtesy Hartman Forderanlagen GmbH)

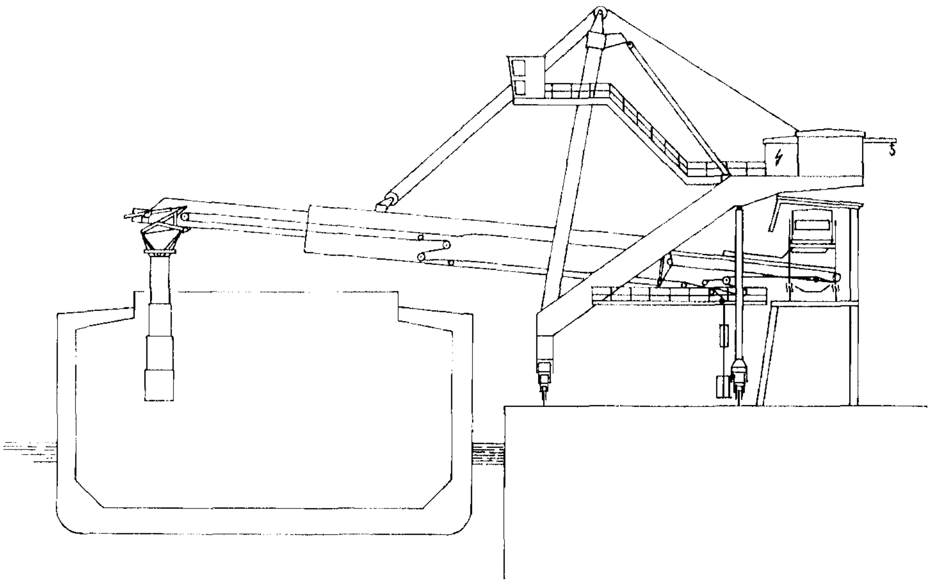


FIG 11.2 MECHANICAL SHIPLOADER
(Courtesy O & K Aniagen und System and PWH Aniagen & System)

CHAPTER 11

LOADING OR DISCHARGING BERTH

Final authority for decisions, need for exchange of information, maximum safe draft, tidal range and sailing draft, air draft, cargo handling equipment and rate, positions of structures on quay, mooring requirements, systems of tendering, systems of access, restrictions on deballasting, communication with berth operators, tonnage on the belt, hours of work, effects of weather, methods of trimming, methods of loading, methods of discharging, ship's information for the berth operator including typical mooring arrangements, methods of information exchange, storing and handling of cargoes ashore

Final authority for decisions when vessel is berthed

WHEN A VESSEL is at a berth decisions made by the master and his officers will have consequences for the berth operators, and decisions made ashore by the operators of the berth will affect the workings of the ship. This raises the question of who has the final authority when master and berth operators cannot agree on cargo operations.

In practice, the number of occasions in which reasonable shipmasters and berth operators cannot agree is very small. Options which are impossible or damaging can be recognised and rejected by reasonable people, and the remaining options must then be weighed according to the benefits of disadvantages which each gives to each party. Both master and berth operators will seek efficient cargo operations.

The master's responsibilities are for care of the ship, its equipment and the cargo, once it has been placed aboard. He must never give his agreement to proposals which will harm the ship or the cargo she carries and he must vigorously resist any attempt to impose such proposals. The berth operator can be expected to be equally firm in defending the interests of the berth, the cargo-handling equipment if based ashore and cargo in his care from damaging actions by the ship.

Weed *for information*

If the time which a ship spends alongside a loading or discharging berth is to be used efficiently, it is necessary for the master to be provided before the ship berths with information about the berth. This will enable the chief mate to devise a loading or discharging programme which takes account of any limitations of the berth. If the chief mate is required to produce a programme without the benefit of such information, his calculations will probably have to be reworked when he eventually discovers that the air draft is limited or the ship is too long for the loader to reach all hatches without shifting ship.

There is a similar need for the berth operator to be provided with information about the ship in order that preparations can be made ashore to load or discharge the ship in the most efficient manner. The information which each party requires about the other can be divided into two categories: that which is essential for efficient planning; and that which is useful.

In practice, standards of efficiency throughout the world vary considerably from berth to berth and from ship to ship. Well organised ships and berths will exchange information in a practical and professional manner. This will enable them to preplan the entire loading or discharging process, although they will be ready to adapt their plans if unforseen circumstances occur. At the other extreme are ships and berths which do not exchange information, which engage in no preplanning, and which merely react to the requirements imposed upon them when the ship has berthed.

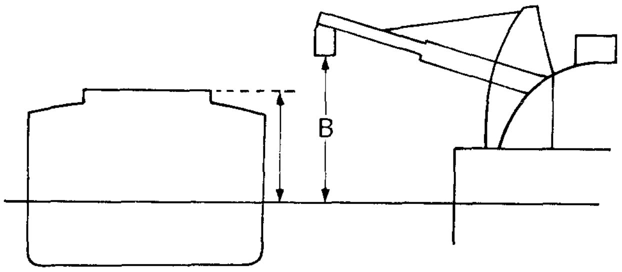
Essential information for the ship about the berth

Maximum safe draft in berth: The master first needs to know the maximum draft at which he can safely remain in the berth at all times. This figure will take account of the need to keep a safe depth of water under the keel and of any rise and fall of tide.

When a vessel is under way in the sheltered waters of a port approach, a minimum safe depth below the keel is usually considered to be D/10, where 'D' is the vessel's maximum draft, although particular ports have their own rules. A smaller allowance below the keel-for example, D/20-may be considered acceptable for a vessel in the berth or entering or leaving it as she will be at rest or moving slowly. A clearance of 1 metre below the keel is often required for Panamax vessels when in the berth. Another factor which must be taken into account when deciding upon a safe depth below the keel is the nature of the bottom. It is prudent to allow a greater margin of safety when the bottom is rocky than when it is mud or sand, since accidental contact with the former is more likely to cause serious damage.

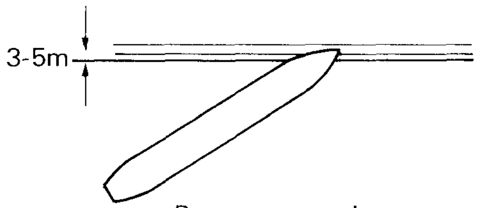
It is normal for the berth operators to decide upon the maximum safe draft. They are not likely to consult the shipmaster for his view as to a safe figure. Unfortunately the figure provided by the berth operators is not always reliable. Depths in the berth may have been reduced by deposits of silt or by cargo residues dropped from grabs or swept from the jetty or from the decks of ships. Low rainfall may have reduced water levels in a river or abnormal meteorological conditions may have caused a reduction in sea level. The berth operators may be under a contractual obligation to provide a certain depth of water and may be reluctant to admit that the actual depth is less than that which they are guaranteeing. Depth survey records may be out of date or inaccurate.

For all these reasons the master must treat the operators' figure with caution when his ship is visiting a berth where a limiting draft will apply. He will be well advised to question the pilot and the berth operators' representatives closely about the frequency with which the berth is surveyed and dredged and the reported water depth available. When there is doubt if sufficient depth of water is available it will be prudent to keep the



Provided that A (height above water level of the hatch coamins) is less than B (minimum air draft beneath the loader) the vessel can both to commence loading.

FIG 11.3



Bows can overhang quay by as much as 3-5 metres as a result of their flare.

FIG 11.4

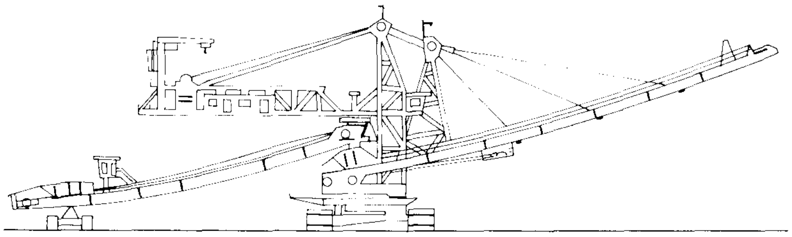


FIG 11.5 STACKER *(Courtesy O & K Aniagen und System and PWH Aniagen & System)*

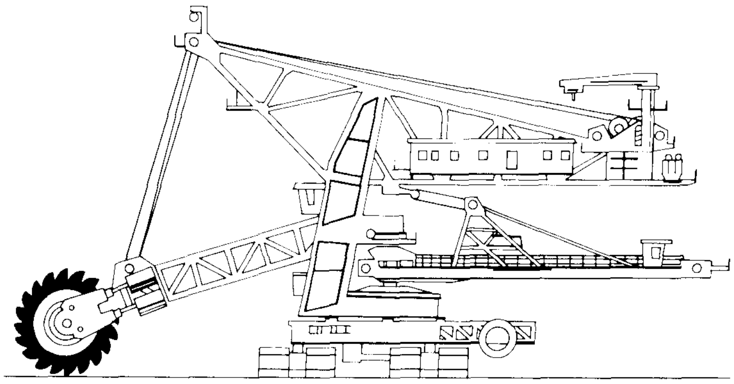


FIG 11.6 RECLAIMER *(Courtesy O & K Aniagen und System and PWH Aniagen & System)*

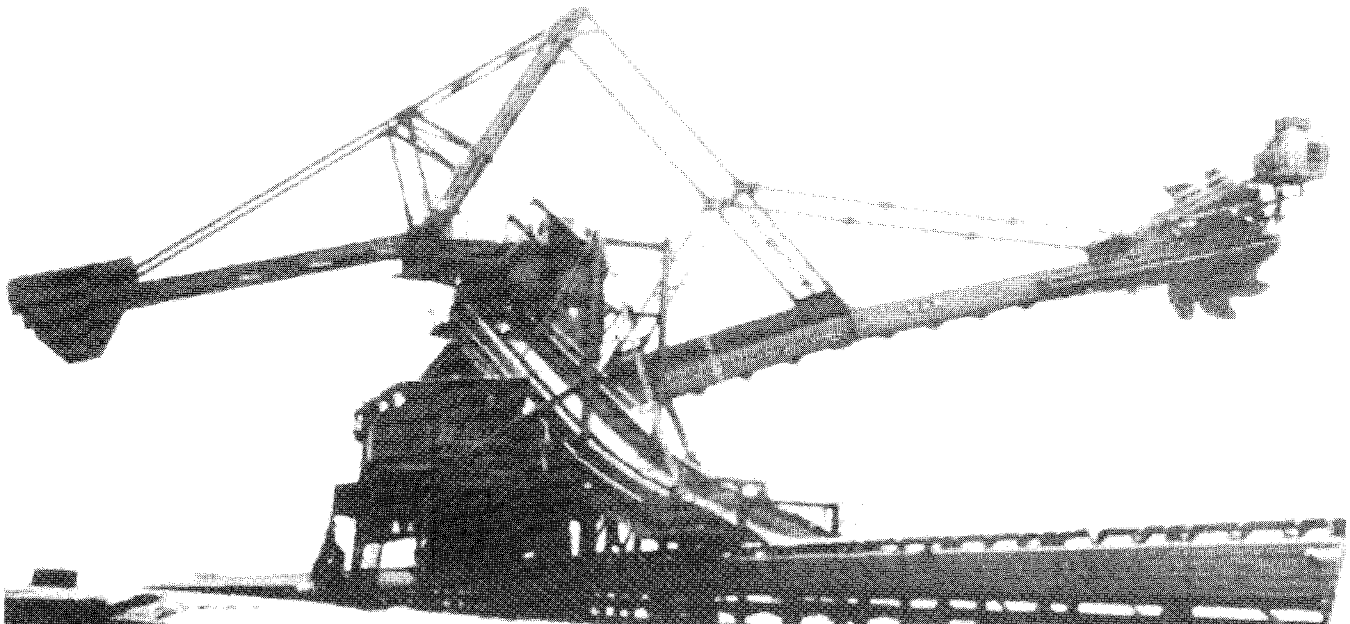


FIG 11.7 STACKER/RECLAIMER *(Courtesy of MAN Gutehoffnungshutte AG)*

echo-sounder in operation producing a sounding trace whilst entering the berth, although the results obtained must be treated with caution since echo-sounders are liable to suffer from a variety of errors at very low underkeel clearances. In addition, soundings with a hand leadline can be taken around the ship once she is berthed. Whilst a berth which is well maintained and smartly run by competent staff inspires greater confidence, even the best run operations can be guilty of errors and there have been a number of instances in which bulk carriers have unexpectedly grounded in the berth.

A few berths exist where the depth is greater at one end than at the other, ships normally being berthed with their sterns in the deeper water. In this case it is necessary to know the maximum depth of water which can be guaranteed at each end of the berth or of the vessel. -

Occasionally the water is deeper in the berth than the minimum depth in the approaches to the berth. Such a berth is known as a 'berth box', where a vessel can stay afloat at all states of the tide, but cannot enter or leave the berth in certain tidal conditions. When these conditions are found the master needs to know the minimum depth in the approaches and the minimum depth in the berth, since loading or discharging may be easier to arrange if the vessel can whilst working cargo reach a draft at one end which is deeper than her sailing or arrival draft. There will be times when the vessel cannot leave such a berth in the event of an emergency such as a fire ashore, and the master should take note of those times.

Tidal range and sailing draft: Where a rise and fall of tide is experienced at a loading berth and the ship is a large one for the berth, loading may be suspended before low water and then completed on the rising tide before the vessel leaves the berth at high water. Similarly, a vessel may berth at a discharging berth at high water, requiring to discharge sufficient cargo during the fall of tide to remain afloat at low water. When operations of this sort are intended, the master will require to know the tidal range and the maximum safe draft for arrival or departure on the top of the tide.

Air draft: A vessel's air draft is generally understood to mean the height of her highest point above the surface of the water at the relevant draft, this information being of interest when deciding if a vessel can pass safely below a bridge or overhead power cable. It is this air draft for the light condition which is sometimes quoted in a ship's particulars.

The expression has a second meaning when applied to bulk loading berths where a principal matter for concern is whether the loading arm is high enough or the vessel low enough for the arm to clear the hatch coaming and be positioned over the hold to commence loading. The measurement which the master needs to reassure himself on this point is the minimum air draft beneath the ship loader. Such an air draft will be least when the river or tidal level is at its highest.

When this figure has been provided the master or chief officer will compare it with the height above water level of the coaming of the hatch where loading is to commence (Fig. 11.3). This can be measured with reasonable accuracy from the vessel's general arrangements or capacity plan, but it must be remembered that when the vessel is trimmed by the stern the air draft increases from aft to forward. The air draft at a forward hatch will be greater than that at a midships or after hatch.

If loading is commenced in after holds and deballasting takes place, it is possible that the forward draft will decrease during the early stages in loading and the air drafts of the forward hatches will increase. When preparing the loading programme, the air drafts of these hatches must be checked to ensure that the ship loader will be able to reach the loading position over the hold.

Details of loading or discharging equipment: To devise an efficient programme for loading or discharging, it is necessary to know whether the loading or discharging equipment is fixed or mobile. If the equipment is fixed or if its movement is limited, it is necessary for the ship to move back and forth along the length of the berth. It is normal for discharging equipment to travel almost the full length of the berth, so that only the largest ships visiting the berth are required to shift to permit discharge from all holds. Ship loaders are also normally designed to move along the length of the berth, except in berths for the smallest ships (mini-bulkers) where fixed loading installations are often encountered. Fixed installations are occasionally used in berths for larger ships. The largest ships which visit a loading berth are likely to have to shift to allow loading in the end holds, since the ship loaders will not be able to reach holds positioned beyond the end of the berth.

The master also requires to know the loading or discharging rate so as to calculate whether the ballasting or deballasting can keep up with the cargo and to decide whether it is desirable to commence ballasting operations prior to berthing. Some authorities quote the maximum theoretical loading rate, even though they know that such a rate is never achieved in practice. This is a useful 'worst case'. If the ship can keep the ballast in step with the maximum loading rate, no problems will be experienced if the actual loading rate is found to be erratic and slower on average than the rate quoted, as is usually the case.

In some loading berths the ship is given a time allowance during which the ship can interrupt loading without penalty, in order to achieve full deballasting before loading completes. For example, at Richards Bay six hours are allowed for stoppages if required by the ship. In many other ports the ship is penalised for all delays caused by the ship. The loading/deballasting plan should be prepared on the basis that no delays will be required, but an allowance for interruptions without penalty is very welcome and helps to ensure that decisions regarding proper deballasting are made for the right reasons and without undue pressure. The master needs to know what penalty-free time allowance is given, if any. Also needed is information as to the number of ship loaders or discharging units to be used, as this will have a significant effect upon the programme.

Positions of structures on quay: Mini-bulkers or handy-sized vessels berthing without the assistance of tugs or with only limited tug assistance will normally approach the berth bows first, with the ship's fore-and-

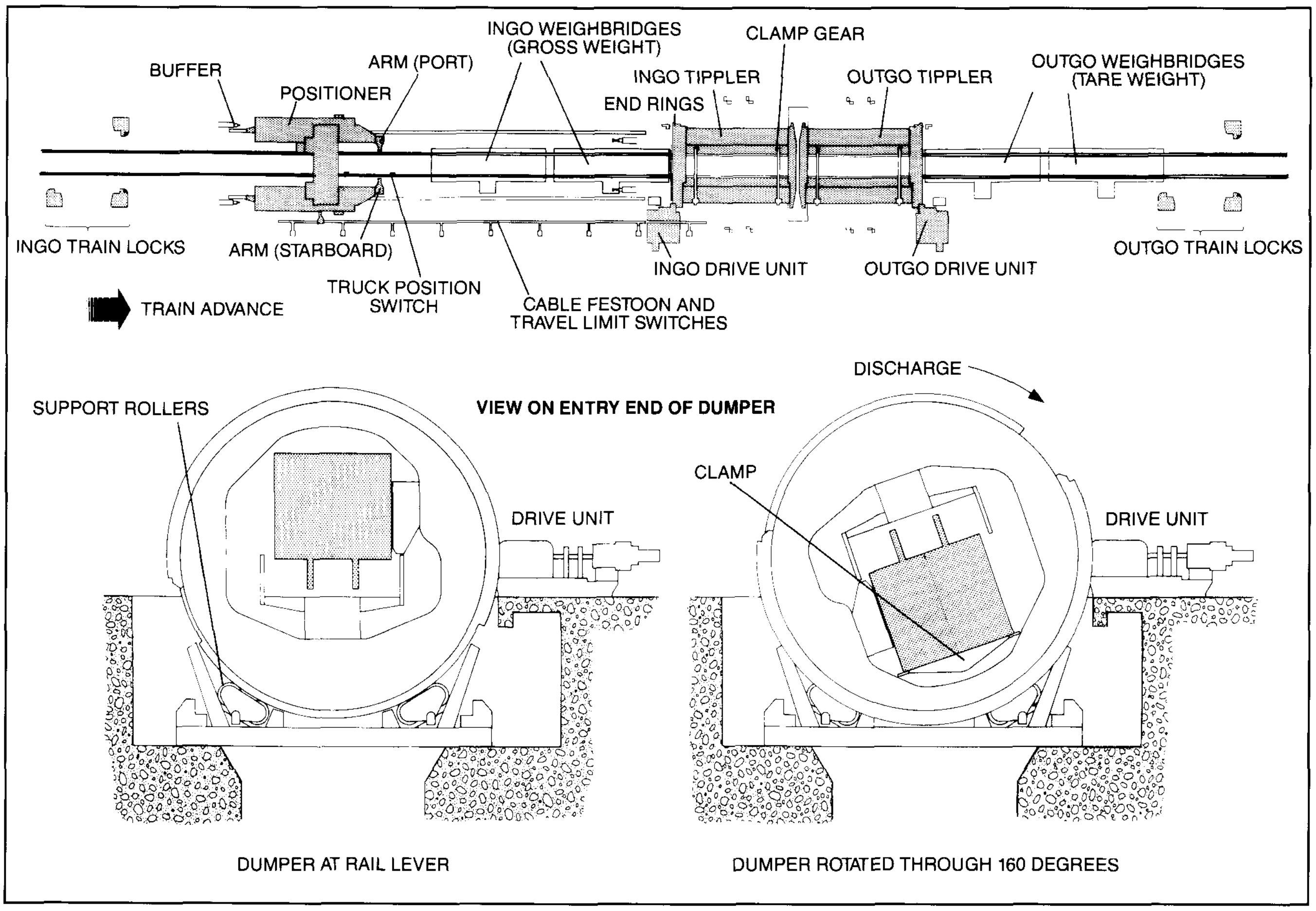


FIG 11.8 RAIL DUMPER SYSTEM TURNS RAIL WAGONS UPSIDE DOWN TO TIP OUT CONTENTS
(Courtesy of Strachan & Henshaw)

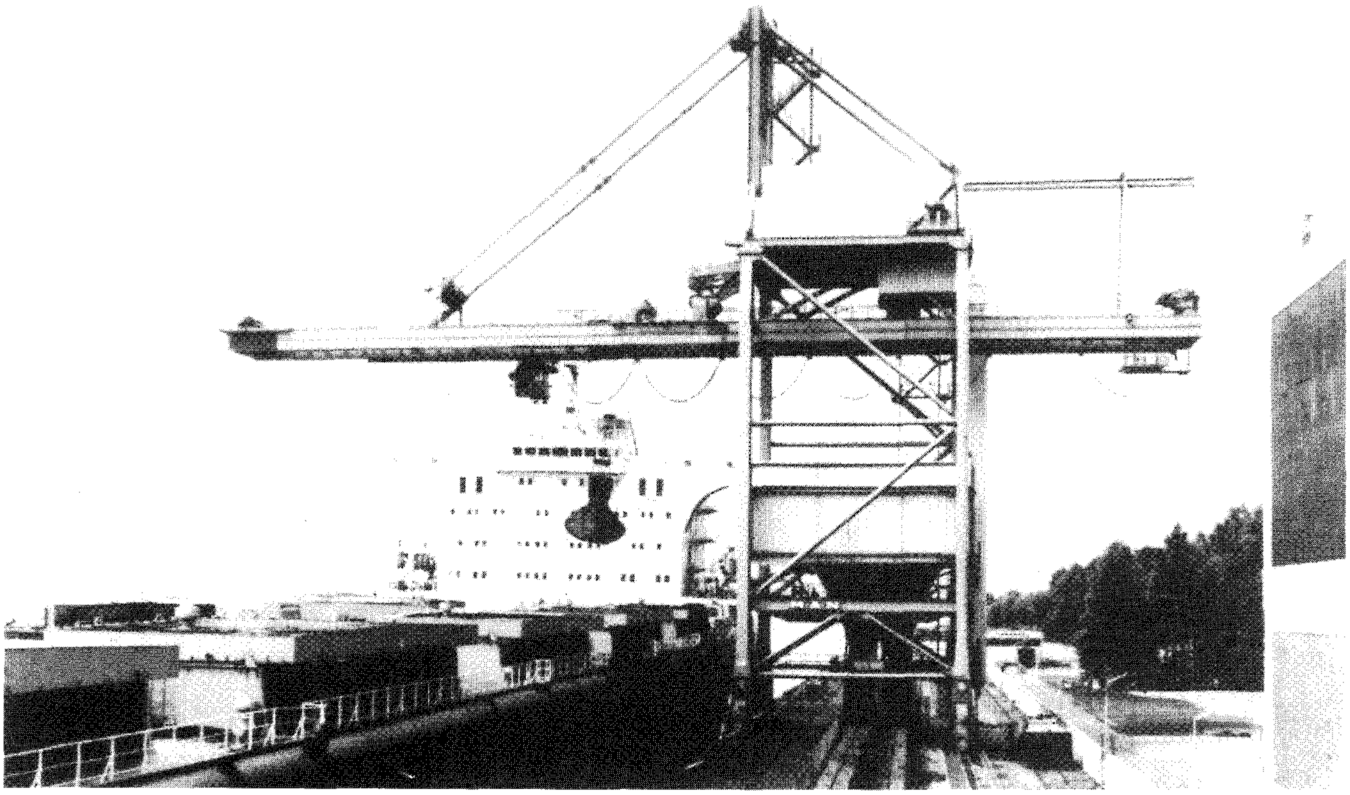


FIG 11.9 GRAB UNLOADER
(Courtesy of MAN Gutehoffnungshutte AG)

aft line making an angle of about 30 degrees with the berth (Fig. 11.4). This often leads to the bows overhanging the berth until the vessel has been swung into alignment with the berth and moored.

For this reason, the master will want to be assured that any travelling loading or discharging gantries and structures on the quay have been moved well clear of the position where the bows of his ship are to be moored, and this matter will be of particular interest to him if he is doing the pilotage, as is more likely on a smaller vessel. Such equipment should be moved completely clear of the berth or alternatively to a position one-third the ship's length from the point where her stern is to be placed, since this is the position where the ship is least likely to overhang the quay during the berthing process.

Similar considerations should not apply to larger (Panamax and Cape-sized) vessels as standard berthing procedures for large vessels require them to be brought to rest parallel to the berthing face, from which position such a vessel is moved bodily sideways by tugs. Most large berths are designed for a zero berthing angle, though a few are designed for a maximum berthing angle of 5-10°. Despite this, it is not uncommon in practice for Panamax vessels to be berthed at greater angles and with inadequate tug assistance in ports where insufficient tugs are available.

A further requirement for ships of all sizes is that any gantries which project over the ship when rigged for cargo work and which could be fouled by the ship's masts or aerials must be raised or moved clear of the berth whilst berthing or unberthing takes place. When there are fixed structures near the edge of the quay a clear description of their positions will be required.

Mooring requirements: Before berthing the master requires to know whether the vessel is to berth port side-to or starboard side-to and what mooring lines will be required. If clearly stated, this information can usefully be passed to the ship before her arrival. Alternatively, it is sufficient if the pilot upon boarding informs the master of requirements, provided that the pilotage is long enough for the ship's company to receive the information and make whatever preparations are needed.

Conventional moorings systems, such as are illustrated in Figs. 11.12 for a range of vessel sizes, should cause no problems to bulk carriers but unusual mooring configurations or unfamiliar shore fittings may require a rearrangement of the ship's mooring lines. Maximum prior warning is advisable for any arrangement which requires ships' personnel to do anything other than land the eyes of the mooring lines of their choice to bollards on a quayside adjacent to the ship.

If lines are to be sent to buoys and require lashings or shackles, if lines are to be doubled and require messengers for hauling the ends back aboard, or if light rope tails are to be attached to the eyes of ropes to facilitate their transfer from mooring boat to quay or dolphin, the ship will need to make special preparations. The same is true if exceptional lengths of mooring line are required for mooring to distant points or if the ship is to provide towing lines for tugs.

There are a few bulk carrier berths where ships are moored with shore lines on shore winches. In these berths, shore personnel can move the ship back and forward along the quay to enable a fixed shiploader to load in a succession of different holds. In these circumstances the officer of the watch must always be informed before the ship is moved by shore personnel.

On Cape-sized bulkers, the expectation will be that lines will be sent ashore by mooring boat, with the first lines ashore being fibre ropes and later lines also being fibre or else wire ropes with nylon tails. Panamax vessels using the same types of moorings as Cape-sized will be met by mooring boats in the better equipped berths, but in many berths they will be required to land their moorings with the help of heaving lines. Handy-sized vessels and mini-bulkers will normally be moored entirely with fibre lines, with the first lines on mini-bulkers normally being put ashore by means of heaving lines. On handy-sized vessels the first lines may be landed either by mooring boat or by heaving line or may be passed directly ashore.

Systems of fendering: Berths designed for vessels of less than about 20,000 dwt berthing unaided by tugs will generally have fenders spaced at intervals of no more than 5-10 per cent of the vessel's length. For much larger vessels berthing with tug assistance, fender spacing can be at intervals of about 25-50 per cent of the vessel's length. A small vessel is likely to experience difficulties when berthing at a berth designed for large vessels and a large vessel is liable to cause damage when berthing at a berth which has been fendered for small vessels. Before a vessel berths details of the fendering should be advised by agent or pilot. The details required may include the type of fenders, whether they are fixed, floating or hanging, their distance apart, and whether any are damaged or missing.

Vessels should always have their own fenders ready as some berths are found on arrival to be insufficiently fendered or with a fender broken or missing in a vital location.

System of access: If the ship's accommodation ladder or gangway is to be used for access when the vessel is berthed, advance warning of what is required and where will help the ship to make suitable arrangements in good time. The alternative is for the berth to provide the means of access, usually in the form of a gangway or system of gangways suspended from the loading or discharging equipment. Information about the access requirements can usually be provided by the pilot in sufficient time to allow the ship's crew to make the necessary preparations.

Restrictions on deballasting: Only one restriction on the deballasting of bulk carriers is likely. In certain areas, such as the North American Great Lakes, Australia and New Zealand, there are restrictions, either compulsory or voluntary, upon the discharge of ballast drawn from the inshore waters of other countries for reasons which are discussed in Chapter 7. Provided that ships satisfy the requirements for clean ballast there will be no restrictions upon deballasting. If they do not satisfy the requirements, deballasting and loading cannot take place and the ship will be sent back to sea to change ballast.

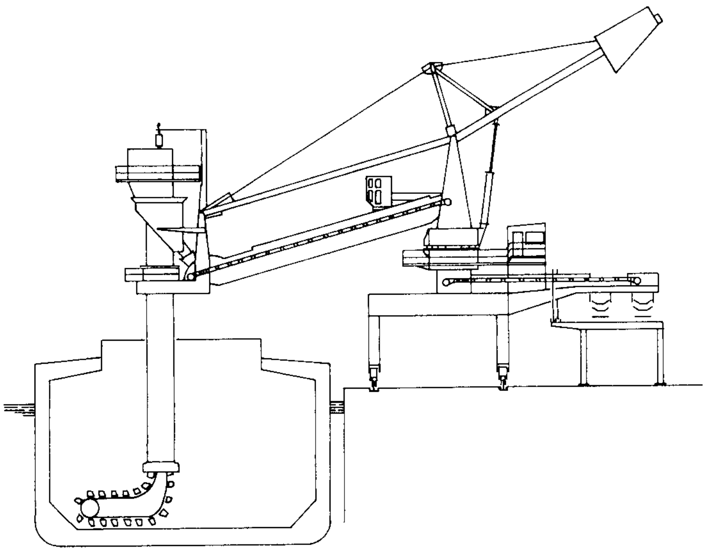


FIG 11.10 CONTINUOUS UNLOADER
(Courtesy OF O & K Aniagen und System and PWH Aniagen & System)

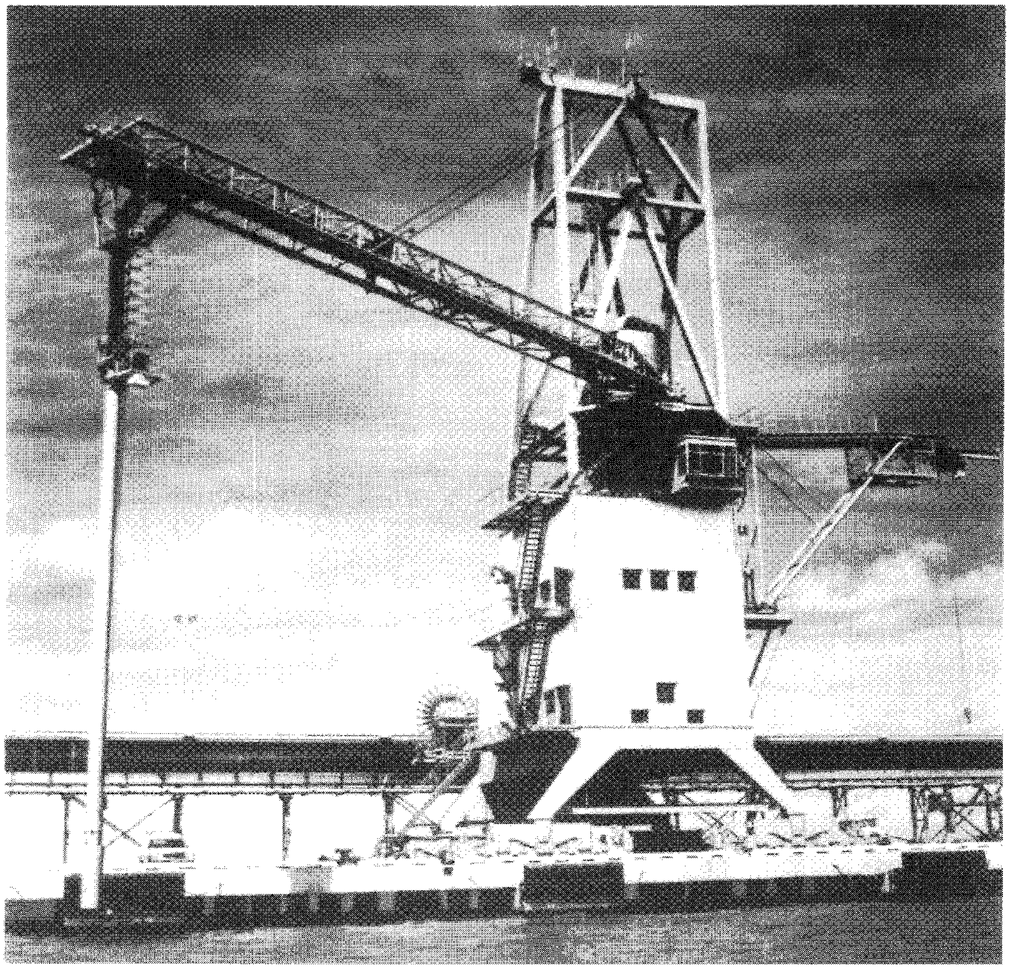


FIG 11.11 SUCTION UNLOADER
(Courtesy Hartmann Forderanlagen GmbH)

Helpful information for the ship about the berth

The preceding paragraphs have discussed the information which is essential to the shipmaster before arrival at the berth if he is to ensure that his vessel's stay is a safe one and that cargo operations are conducted with maximum efficiency. After berthing there is more information which the master will find useful and the following paragraphs discuss the information which is particularly relevant to the operation of bulk carriers. Items of general information, such as port emergency communications, port services and the provision of stores, bunkers and fresh water, have not been discussed.

Cargo work-the loading berth: The master or chief officer will want to know how he can make contact quickly with the loading supervisor to discuss any problems or to stop the loading in an emergency. At most loading berths a man with a VHF radio will be stationed on deck close to the hold being loaded, but occasionally such people disappear when most needed and it is useful to know the location of the supervisor's office or to establish a VHF link with him.

Tonnage on the belt: The normal tonnage of cargo on the belt (i.e., on the loading conveyor belt) is an important fact. If an unplanned stop is ordered it will be normal practice to continue loading until all the cargo has been cleared from the belt, because the belt cannot be restarted when it is laden. If the belt is a long one, the tonnage on the belt can be very considerable, being as much as 1,000 mt in some berths where Cape-sized vessels are loaded.

Hours of work: The master will want to know the hours of work of the loading or discharging gangs and the timing of any routine interruptions for change of shift, shunting of rail wagons, routine maintenance of equipment or other purposes.

Effects of weather: The master needs to know the customs of the port with regard to working cargo in adverse weather-for example, in rain, snow, fog or high winds. Discharging cranes may be prohibited from working in winds above Beaufort Force 6 or 8 and when fog restricts visibility to less than 50 metres. The master will want to ensure that he is in agreement with the policy of the port or the cargo representatives regarding the stopping of cargo work and the covering of holds in the event of rain.

In ports where objections are received on environmental grounds when dusty cargoes blow over residential areas, work is liable to be stopped in any strong winds. He will also want to know if there is any possibility that he will be ordered to leave the port in event of a tropical revolving storm.

Methods of trimming: Trimming, when mentioned in connection with the loading of a cargo, is understood to mean the levelling or part-levelling of the cargo. Trimming is undertaken to reduce the danger of cargo shifting (i.e. slipping into a new poosition) and thereby putting ship's stability at risk or to ensure a better filling of any empty spaces to increase the quantity of cargo carried. Trimming may also be carried out to reduce the surface area of cargo exposed to air and to level the cargo in the hatch square to permit the hatch covers to be closed.

When loaded, closeweight cargoes such as ores and mineral sands may be spout trimmed, mechanically trimmed or untrimmed. If the maximum reach of the loading spout is only to the ship's centreline and if the spout is not fitted with any device for spreading the cargo, it is not possible to spout trim the cargo. Devices used to improve the effectiveness of spout trimming include a loading shoe (Fig. 11.14) which shoots the cargo off at an angle, and a spinning plate which flings cargo out all round, thus trimming reasonably level at all stages of the loading. Deflector plates, separate from the loading spout, can also be used to direct cargo into the sides and end of the hold.

It is also possible to trim ore cargoes level by mechanical means, such as the use of bulldozer or front-end loader placed in the hold after completion of loading. This practice is becoming more common, particularly with concentrates. It is now (1992) a requirement in Australian ports, and may be required elsewhere in the future as more countries enforce the BC Code[22], which recommends that any cargo which may liquify should be trimmed reasonably level on completion of loading.

Low-density cargoes such as grain may be shovel trimmed by trimmers-men or women who shovel the cargo into the empty spaces around the hatch coaming. The trimming of cargo holds during discharge is the removal of such residues of cargo as cannot be removed by the main means of discharge, usually the grabs. (This process is discussed in Chapter 16.) When the master knows the method of trimming to be employed in loading or discharging, he will know what precautions will be required to ensure that the process is done efficiently.

Pollution: It is always desirable that pollution by dust or by odour from the cargo is kept to a minimum and this is particularly true where bulk terminals are situated near to private housing. This may call for special precautions such as keeping hatch covers partly closed during strong winds or winds from certain directions, or at all times.

Methods of delivering the cargo to the vessel: Some of the lighter and more dusty cargoes such as grain and cement are loaded direct from the silo using enclosed systems, and bulk cargoes are occasionally loaded by grab, but it is more common for dry bulk cargoes to be loaded by mechanical ship loaders in which the cargo is brought over the ship by a conveyor belt contained within a suitable boom framework (Fig. 11.2). The boom, or arm, may be telescopic, and may be capable of luffing (i.e., being raised and lowered), and slewing (swinging round in the horizontal plane), thereby increasing the number of positions in which the cargo can be delivered (Fig. 11.13). In addition the entire ship loader is normally designed to travel along the quay on rails. When the cargo has been brought over the ship's hold by conveyor belt it is directed into the hold by a spout or chute which may allow it to fall vertically, or may be fitted with a shoe which will throw it to port or starboard for trimming purposes (Fig. 11.14), or with a spinning plate which will fling it in all directions.

Cargo work-the discharging berth: Solid bulk cargoes are removed from the holds of ships by grabs, by continuous mechanical unloaders or by suction

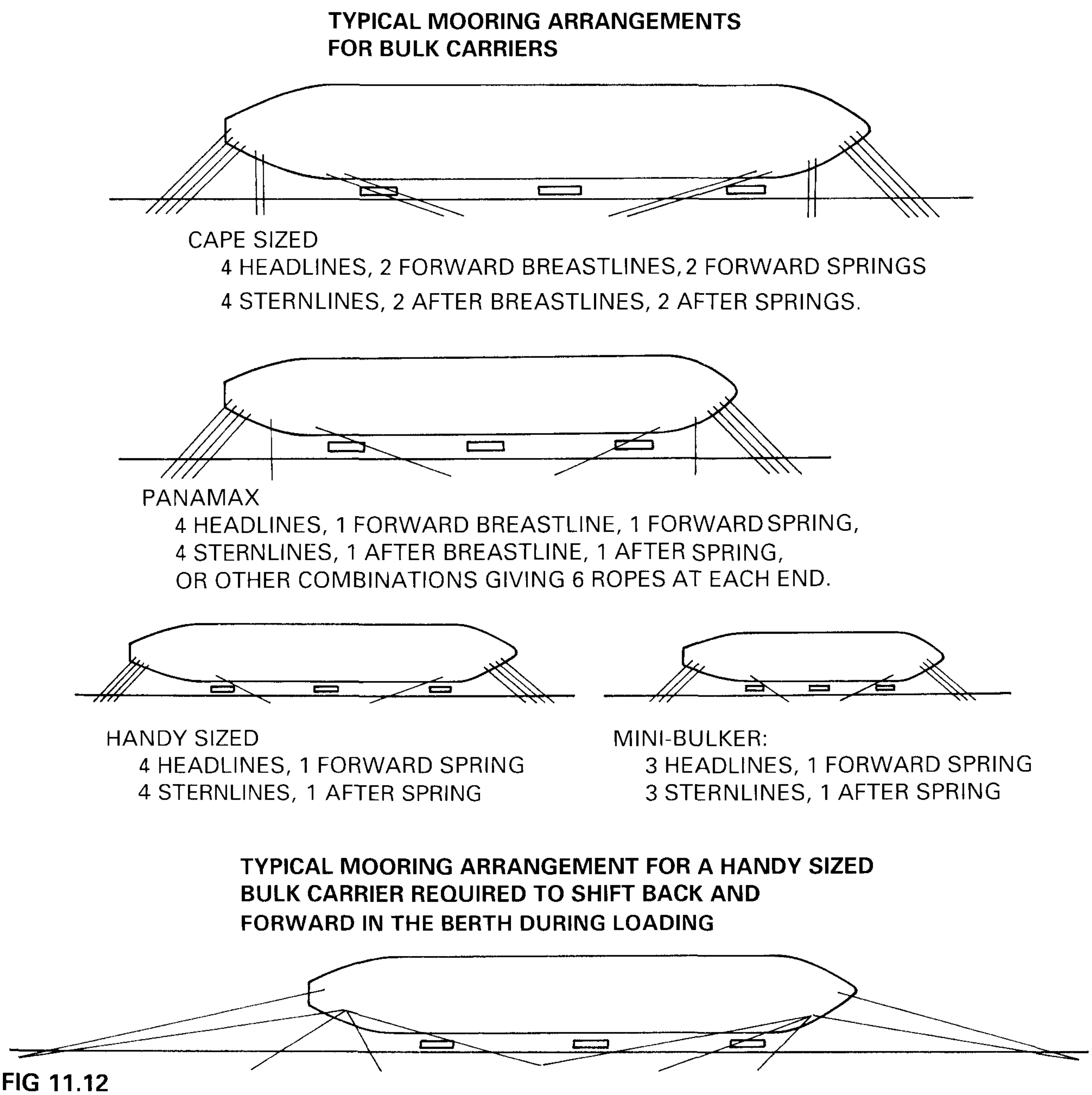


FIG 11.12

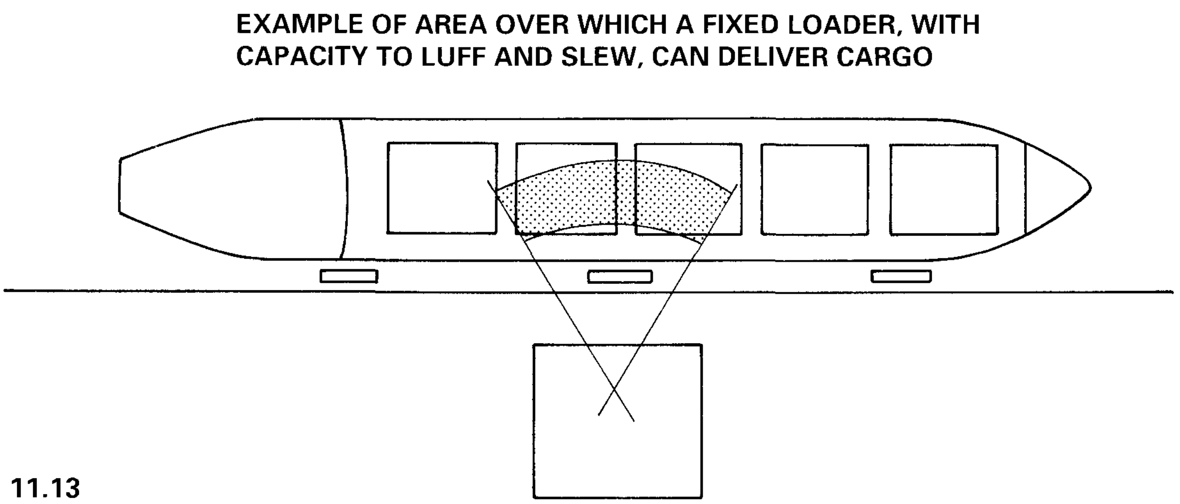


FIG 11.13

unloaders, each of which is normally able to travel most of the length of the berth.

Grab unloaders (Fig. 11.9) can transfer cargo direct from the ship's hold to a barge or to a stockpile next to the berth. Alternatively, they can drop cargo into a hopper built into the structure of the unloader or placed alongside it. From the hopper the cargo is fed on to a conveyor belt or into a road truck or rail wagon for transfer to a place of storage.

Dockside cranes and floating cranes equipped with grabs can perform much the same variety of tasks as the grab unloaders within a smaller area.

Continuous unloaders may take the form of an endless chain of buckets (Fig. 11.10) or an Archimedes' screw emptying on to a conveyor system. Such systems result in less dust and spillage than grab systems and provide a more steady flow of cargo on the conveyor.

Suction unloaders (Fig. 11.11) are used to draw cargo out of the hold through the suction pipe and on to a conveyor system for delivery to the silo or transport system. Alternatively, suction discharge can be carried out by vacuvators, which are portable units powered by diesel motors. These units can be placed on a ship's deck and used to draw cargo from her hold and deliver it through a discharge pipe to a smaller vessel moored alongside or a rail wagon or road truck placed close by on the quay.

Essential information about the ship for the berth operators

Extreme dimensions: To plan the ship's visit, the berth operators will normally require to know some or all of the ship's extreme dimensions, (length overall, extreme breadth, maximum draft, air draft to highest point on ship and air draft to coaming of first hold to be worked). For planning the ship's position in the berth, the distance from stem to navigating bridge may be required, as all the cargo holds fall within this distance.

Distribution of cargo, and loading or discharging programme: Before commencement of cargo operations the berth operators will require to know the ship's planned loading rotation, or loading sequence. The document which shows the loading rotation will list the pours in order, showing for each pour the tonnage to be poured and the hold which is to receive it. The berth operators may have no need to know the planned deballasting sequence and the planned draft and calculated longitudinal stresses at the end of each pour, but it is recommended that they be given a copy of the entire loading/deballasting programme, set out on The Nautical Institute's Cargo Operations Control Form (Appendix 9.3). This document lists the loading rotation. In addition it shows the berth operators that the plans and calculations necessary for the loading have been completed, reassurance which will sometimes be welcome.

If the purpose of the visit is to discharge cargo, the stowage plan listing the commodity, tonnage and consignee of the cargo in each hold will be required as will the ship's planned discharging sequence. This information, too, can usefully be provided on The Nautical Institute's Cargo Operations Control Form.

Ship's cargo-handling equipment: When the ship is equipped with cranes or derricks and when that equipment is to be used for cargo operations, the berth operators are likely to require details of the equipment. Information required may include the number and capacity of the cranes or derricks, their cargo working rate in tonnes/hour, the holds which each serves, their maximum outreach and whether they are equipped with grabs.

Other information: In particular cases there is much other information which berth operators may require to know about a bulk carrier, but there are too many possibilities associated with the loading or discharge of particular bulk carrier types or specific cargoes to do more than to list a few examples here. Information required might include cargo compartments suitable for grab discharge, maximum dimensions of clear deck areas, dimensions of hatch coamings and maximum permitted tanktop, hatch cover or deck loadings.

Useful information about the ship for the berth operators

Ship's mooring lines: The berth operators may want to be sure that the ship is equipped with suitable mooring lines which will hold her safely alongside throughout her stay and which will prevent ranging which might result in damage to loading or discharging equipment. Large vessels may be asked to report in advance the number and types of lines which they intend to use and they may be provided by the berth operators with recommended mooring layouts. Whilst the berth operators do not normally have the authority to instruct the master what lines he must use, they do have the authority to refuse to bring his vessel in or to keep her alongside if they do not consider her moorings satisfactory.

It has been written[41] of VLCCs (and it is equally true of bulk carriers): 'VLCCs can be found with all synthetic mooring ropes, with mixed moorings (synthetic ropes and wire lines) and with all wire moorings (with and without synthetic tails). Rated brake capacities can vary from 30 to 90 mt. Winch and fairlead locations can vary significantly from ship to ship. Ship crews will have differing degrees of expertise in mooring matters and varying philosophies concerning maintenance and/or replacement of critical items of mooring equipment.'

The following notes on the mooring of bulk carriers are intended as general guidance for those unfamiliar with the dry bulk trades. No attempt has been made to provide detailed and precise advice, which would depend upon the ship, the berth and numerous other factors. For detailed recommendations on mooring large vessels readers are referred to reference[41].

- Typical mooring arrangements for bulk carriers moored with fibre ropes of appropriate size in good condition are shown in Fig. 11.12. They assume moderate weather conditions and no significant current or swell.
- A bulk carrier's minimum outfit of mooring lines is governed by the equipment letter allotted to her by her classification society.
- Bulk carriers of all sizes up to and including Cape-sized are usually equipped to moor entirely with fibre ropes.
- The largest fibre ropes in general use for mooring are

84mm diameter, though 64 mm-72 mm are more widely used.

- A mini-bulker is likely to use 32 mm-40 mm fibre ropes.
- On modern Cape-sized and Panamax bulk carriers, all the mooring ropes used in a normal tie-up will usually be stowed on powered reels. A Cape-sized bulker will have as many as 16 powered reels.
- Powered reels may be fitted with self-tensioning capability. The self-tensioning device causes the reel to take up or pay out on the line until the selected tension has been obtained. If the same setting is used for every reel, all the ship's lines will have the same tension.
- When lines have been satisfactorily tensioned they should not be left in the self-tensioning mode, but should be put on the brake. This ensures that if the forces acting on the ship change, she will not start to creep along the berth.
- Older and smaller ships will probably not have ropes or wires on powered reels. Without powered reels the work aboard ship during mooring will be slower and will require more labour.
- If a ship uses wire ropes as mooring lines each will normally be provided with a nylon or other fibre tail of length about 11 metres.
- The largest size of wire rope likely to be used for routine mooring is 44 mm diameter.
- Provided that all lines are of a suitable size and are in good condition, a ship that is moored with wire ropes will require about 25 per cent fewer lines than will the same ship if moored with fibre ropes.
- Mixed moorings, comprising full-length synthetic ropes used together with wire ropes, are not recommended. When it is necessary to use mixed moorings, wire ropes should be used for one type of mooring and synthetic ropes for another. For example, all spring lines can be wire ropes and all headlines, sternlines and breastlines can be synthetic ropes. It is not acceptable for some headlines to be synthetic and others to be wire, as the wire, which stretches less, will take most of the load.
- A vessel which is required to shift along the berth during the course of cargo work will have some of her moorings led to more distant mooring points to assist the shifting.
- In a berth which is exposed to strong tides or currents or where bad weather is expected, additional moorings will be required to supplement those normally used.
- Moorings with a short scope, or length of line used outside the fairlead, must be adjusted more frequently that those with a long scope to correct for the effects of working cargo and ballast and for the rise and fall of tide.
- All-wire mooring lines must be adjusted more frequendy than wires with synthetic tails to correct for the effects of working cargo and ballast, and for the rise and fall of tide.

Access: If the ship is to provide the means of access, the berth operators may require to know the preferred position of the ship's gangway, or the position of the ship's accommodation ladder. The latter maybe installed adjacent to the accommodation or on larger ships part-way along the length of the ship's parallel body.

Methods of providing information

Information for master: The information which the master needs regarding the berth and the intended loading or discharging operation may be given to him in writing, by means of a cable, telex or facsimile message from the terminal operator ship's agent, or may be delivered in the form of a port or terminal brochure, or a data sheet prepared by the port, terminal or agent. The most effective means of passing information is likely to vary from port to port and information provided in any of the above forms will be acceptable if it is clearly written, accurate, relevant and timely.

Information passed verbally, in conversation between the master and the pilot, agent or port official is useful, too, to emphasise important matters and help with understanding if there is a language difficulty, but verbal advice is best when supported by written information which can be left with the master.

Information for berth operators: The berth operators can obtain information about the ship from the owners and charterers and from published works of reference such as *Lloyd's Register and Clarkson's Bulk Carrier Register.* However, for information which is up to date and accurate the most reliable source ought to be the vessel's master and any information upon which the berth operators intend to rely should be provided and/or verified in writing by the master.

Storing and handling of bulk cargoes ashore

A basic knowledge of the methods used ashore for the handling of bulk cargoes can help with understanding of the reasons for interruptions in the loading or discharging process.

Stockpiles: The cargo may be stored in a stockpile in the open air. Stockpiles are large heaps of bulk cargo, often weighing thousands of tonnes, stacked upon an area of level land, the base of the stack resting upon hard packed soil or a concrete or tarmac surface. The storage yards at the Delwaide Dock Terminal in Antwerp, for example, have a stockpile capacity of 6 million tons in an area of 80 ha (200 acres). If the commodity is of high value, or if there is concern about the pollution which would result from dust blown away, the stockpile is likely to be protected by fresh water sprays. The Richards Bay Coal Terminal, for example, uses sprays to maintain a surface moisture content of 6-9 per cent in its stockpiles[38].

Cargo arrives at the stockpile by rail wagon, by barge, by conveyor belt or ropeway transportation system direct from the mine or quarry or by road truck if the quantities are relatively small. The cargo is likely to be placed in the stockpile by grab (from a crane) or by stacker (Fig. 11.5). A stacker is an arrangement of conveyor belts and booms similar to a shiploader. It can be used to deliver the cargo to the stockpile after it has been tipped from the rail wagon or road truck, or grabbed from the barge into a hopper which pours it onto the conveyor belt.

Bulk cargo is removed from the stockpile by a reclaimer, which feeds the cargo onto a conveyor belt for delivery to the ship. A reclaimer (Fig. 11.6) is a machine which uses a bucket wheel or a scraper belt to remove cargo from a stockpile and feed it onto a conveyor. Often a single unit is built to operate as a combination stacker/reclaimer (Fig. 11.7) which will put cargo into a stockpile or remove cargo from the stockpile. At some loading terminals such as Vlarmorilik in Greenland and StjernØy in Norway, where the mine is adjacent to the loading berth, the stockpile is underground within the mine.

Silos: These are used mainly for bulk grain, animal feeds and oilseeds, and for mineral cargoes with high values or dusty characteristics. Filling and emptying them can be achieved by mechanical means assisted by gravity or by pneumatic means. Handling capacities of 1,000 t/h or more can be achieved. When a ship is loaded from a silo the cargo will normally be delivered by means of a pipe or hose suspended from a boom (Fig. 11.1). Whilst silos are large structures they may be subdivided into a large number of bins. The contents of a bin may be the minimum pour that can be delivered.

Rail wagons: When bulk cargoes are brought direct to the loading berth by rail wagons it is normal to use a railcar dumper system (Fig. 11.8) to capsize the wagons, sometimes two at a time, and tip out their contents into the hopper situated below them. From the hopper the cargo will be delivered by conveyor to the stockpile or to the ship. This process of dumping or capsizing the wagons is also known as tippling. Theoretical tippling rates can be as high as 7,800 t/h achieved with 75 wagons on single rail line, but this is dependent upon the faultless operation of an extensive marshalling yard and it is unlikely that it is often achieved in practice. Richards Bay Coal Terminal, however, has three railcar dumper systems in tandem, gi\ing a theoretical rate of delivery to the stockpiles of more than 15,000 t/h.

Road trucks: Road trucks delivering bulk cargo to a terminal will normally back up a ramp and tip their contents into a hopper, feeding a conveyor, serving the ship loader.

Barges: When bulk cargoes are delivered to the loading terminal by barge or by ship for transhipment, transfer to the loading ship or stockpile will often be achieved by grab unloaders, otherwise known as gantry cranes (see Fig. 11.9 and Front Cover), though fixed or floating cranes, or vacuvators, can also be used. Grabs with a capacity of 30-50 mt are common in the major bulk transhipping ports, and there is a grab with 85 mt capacity at Europoort. Grab unloaders can also be used to load vessels by transferring cargo from the stockpile direct to the ship's hold.

Sources

22. *Code of Safe Practice for Solid Bulk Cargoes.* International Maritime Organisation. 1991.

38. Faubert, J. 'Bulk Port Design-An Expert Overview'. *Bulktrans '91.* C.S. Publications Ltd. 1991.

41. *Guidelines and Recommendations for the Safe Mooring of Large Ships at Piers and Sea Islands.* Oil Companies International Marine Forum. 1978.

42. *Port Handbook.* Dampier Port Authority, c1990.

43. *Advice to Vessels Bound for Port Cartier.* La Compagnie Minière Québec Cartier. 1989.

197. *Ponta da Madeira Terminal Port Information.* Companhia Vale do Rio Doce. 1988.

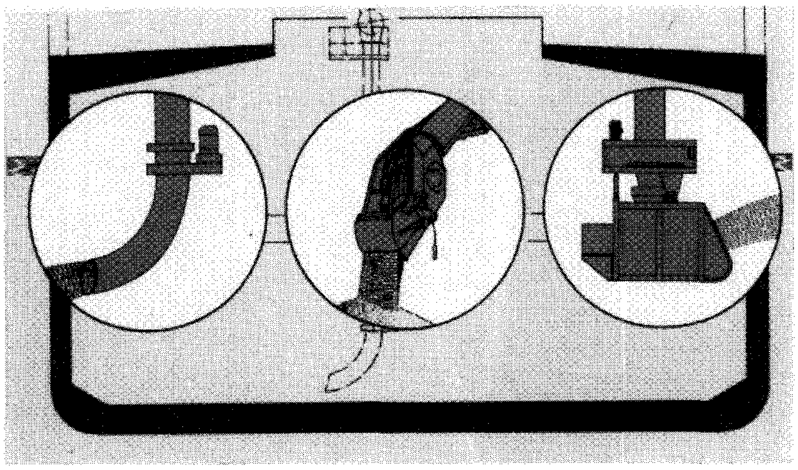


FIG 11.14 SPOUT TRIMMIMG SHOES
(Courtesy of Hartmann Fo'rderan/agen GmbH)

CHECKLISTS-Essential information about the loading or discharging berth

The underlisted information about the berth will, or may, be required for the safe and efficient planning of the ship's visit.

- ☐ Maximum safe draft in berth.
- ☐ When depths vary along the length of the berth, maximum safe draft at each end of berth.
- ☐ Minimum depth in the approach to the berth if less than the depth in the berth.
- ☐ Tidal range.
- ☐ Proposed sailing draft.
- ☐ The number of hours either side of high water (the tidal window) during which the vessel can berth or sail because of draft limitations.
- ☐ The minimum air draft beneath the ship loader.
- ☐ Characteristics of loading or discharging equipment.
- ☐ If the equipment is fixed or any limits on its movement.
- ☐ The maximum theoretical loading or discharging rate.
- ☐ The number of ship loaders or discharging units to be used.
- ☐ Positions of travelling structures on quay at time of berthing.
- ☐ Positions of fixed structures on quay.
- ☐ Whether berthing port or starboard side-to.
- ☐ Mooring lines required.
- ☐ Warning of unusual mooring arrangements.
- ☐ Details of fendering at the berth.
- ☐ Who is to provide means of access to ship, and where access is to be placed.
- ☐ Any restrictions on deballasting.

Information about the ship

The underlisted information about the ship will, or may, be required by the berth operators for the safe and efficient planning of the ship's visit.

- ☐ Estimated time of arrival.
- ☐ Arrival draft and trim.
- ☐ Quantity of cargo required.
- ☐ Cargo loading sequence hold by hold, stating grades and tonnages required for each pour.
- ☐ Deepest departure draft.
- ☐ Distance between keel and hatch coaming or air draft of loading hatch coaming on arrival.
- ☐ Ship's length overall and maximum beam.
- ☐ Air draft to highest point of mast/aerial.
- ☐ Distance from stem to bridge front.
- ☐ Details of layout and dimensions of cargo spaces, hatchways and upper decks.
- ☐ Details and capacities of ship's cargo-handling equipment.
- ☐ Position of ship's accommodation ladder.
- ☐ Number, type and condition of moorings.
- ☐ Condition of winches.
- ☐ Anticipated deballasting time.
- ☐ Defective equipment aboard ship (for navigation, cargo, safety).

CHAPTER 12

LOADING PERIOD

Importance of the loading period, arrival in berth, preloading surveys, acceptability of offered cargo, duties of ship's officers, loading/deballasting programme, monitoring loading and deballasting, supervision of work of the crew, liaison with loading staff, damage to ship or cargo, maintenance of full records, chief mate's role as troubleshooter, master's role, shifting ship by warping, safe procedures for working cargo

THE LOADING PERIOD is a most important one for the master of a bulk carrier and for his officers. Loading is usually more rapid and concentrated than is the carrying or discharging of the cargo. Events happen quickly. Unexpected problems can arise if the cargo is unfamiliar or the port unknown and will require prompt attention to ensure that the cargo is loaded in a safe and satisfactory manner and that the ship and cargo are protected from damage throughout. A high level of alertness will be required from the start to the end of the loading period.

The system used by the deck officers for sharing the supervisory work during loading will be governed by the number of officers carried, their experience and the normal procedure for ships of their flag or ownership. There will always be at least one deck officer on duty during loading, under the direction of the chief mate. The chief mate will himself usually take charge of all important steps in the loading, such as draft surveys, the completion of deballasting and the calculation and execution of trimming pours. In smaller ships with only one or two mates he will also take his turn on cargo watch, as he may also do on larger vessels. The master will hold himself available to advise where required or will take a more active supervisory role if his officers are inexperienced or unreliable.

Arrival in the berth

When a vessel approaches the berth through sheltered waters, it is normal to berth with the first hold to be loaded already open, ready for commencement of loading, and if conditions are favourable several or all the holds will be opened. This makes a preloading inspection a quicker and easier process when such an inspection is required and avoids the possibility of moving hatch covers, and thereby altering the vessel's trim or list, during a draft survey. Hatches open, ready for loading, may be a requirement for the tendering of notice of readiness.

On vessels which are required to change position under a fixed loader, the pilot before berthing will require to know the first loading position so that he can position the ship ready for commencement of loading.

Preloading surveys

Before the commencement of loading there will often be a requirement for a preloading survey of the holds and for a draft survey. Where the vessel is a regular trader employed on a period time charter carrying the same commodity every voyage, preloading surveys of the holds are less likely to be required except when the cargo is easily contaminated. Draft surveys by independent surveyors are not required when the charterparty states that the tonnage carried isto be established by some other means such as shore weighing, although the ship's personnel should always make their own survey to calculate a ship's figure for cargo loaded.

Normally the ship's agent will be able to advise the master whether surveys will be required, if there is any doubt. When surveys are undertaken it is sensible to treat surveyors with courtesy and consideration. A surveyor undertaking a preloading survey of holds should be accompanied by an officer, preferably the chief mate, and should be helped to gain access to holds and assisted with lighting and ladders, if required. Careful note should be taken of any items which he notes for attention and the officer must be sure that he has a clear understanding of what the surveyor requires. Any work required by the surveyor should be given top priority, since failure to pass the survey will normally mean that the ship goes off hire until such time as she is passed as ready to load. A hold inspection certificate is at Appendix 14.1.

The draft surveyor should also be accompanied by an officer when taking his readings. For soundings of bunker tanks the chief or second engineer is usually the appropriate person, whilst the chief mate should accompany the surveyor to read the drafts and to check the bilge, ballast and fresh water soundings. It is fairly common for the draft surveyor to board the vessel and announce that he has already read the drafts, but this should not be acceptable to a conscientious chief mate. An officer should check and agree the readings obtained, and should independently complete a set of calculations to obtain figures for bunkers, ballast and constant.

Condition of cargo offered

When the vessel is berthed and the master has satisfied himself that she is safely secured alongside, information will be exchanged, as described in Chapter 11. A copy of the *ICS Ship/Shore Safety Check List*[m] may be completed and the loading programme, which can be set out in The Nautical Institute's Cargo Operations Control Form (Appendix 9.3), should be confirmed. Thereafter the master and his officers must satisfy themselves that the cargo is acceptable.

Where possible the cargo should be inspected ashore in the stockpile, silos, trucks or wagons or in the lighter before it is loaded, as it is always easier to object to unacceptable cargo before it has been loaded and many bulk ports do not have the facilities to discharge cargo from a ship's holds once it has been loaded. Officers must be on the lookout for any defects which would make the cargo unacceptable or which might later be blamed on the ship if not seen, recorded and made the subject of a protest. Bulk grain which is wet, sprouting, mouldy or infested would be unacceptable, as would wet or caked fertilizer, rusty cold rolled steel coils or bulk ores contaminated with a different cargo or containing excessive moisture. Coal contaminated with iron ore, wheat in a cargo of corn, and timber stained with oil have all been found and rejected by alert officers. The great number of possible cargoes, each with many possible causes of damage, make it impossible to do more than provide examples here.

The *IMO Code for Solid Bulk Cargoes*[22] states that the shipper should provide the master with details of the nature of the cargo so that any safety precautions which may be necessary can be put into effect. The shipper should also provide a document stating the transportable moisture limits of the cargo and a certificate of moisture content showing the average moisture content of the material at the time that the certificate is presented to the master. In practice all this information is normally contained in a single document, the declaration by shipper (Appendix 14.10), described in Chapter 14.

The master should request the foregoing information by cable before arrival and should insist upon receiving it before loading commences. With effect from 1 January 1994 the provision of this information by the shipper is a Solas requirement. In most loading ports except the more isolated ones the necessary information is reported (in 1993) to be readily available.

Where the cargo cannot be inspected ashore it should be regularly inspected at the point of delivery aboard ship, where officers will hope to avoid the painful experience of a certain pair of chief and second mates. They were standing by the hold at 0200 hours on a winter morning to watch the commencement of loading aboard a bulk carrier in Chicago. What they saw was 50 tonnes of ore poured into the hold and then rapidly covered with the cargo of petcoke/ This seems to have been a case in which the shiploader operator cleaned the conveyor belt of a previous cargo into the ship's hold, a practice which is completely unacceptable. It was not possible to stop the loading when this incident occurred because the operator of the shiploader was out of sight (perhaps deliberately), but the fact that the incident had been observed made it possible for the ship to issue a letter of protest.

Duties of the officer of the watch

During the loading period the officer of the watch (OOW) must be concerned with a number of matters, some of which are common to all ships and other which are specific to bulk carriers.

Loading/deballasting programme must be studied and understood: A copy of the loading/deballasting programme prepared by the chief mate will be provided for the officers of the watch. This may be the same programme as has been passed to the loading foreman or it may contain extra details, of ballasting, for example, which the chief mate considers that it is not necessary for the shore personnel to know. Each OOW must make sure that he understands every item in the programme and what must be done at every stage.

Cargo loading process must be monitored: Monitoring of the cargo loading must have the highest priority because it is better to get things right the first time, since it can be very difficult to correct mistakes in loading. Ships' personnel must keep in mind the fact that the interests of the shippers of the cargo and of those employed to load it are not necessarily the same as those of the ship's personnel. What is convenient for one party may be quite the opposite for another.

The initial positioning of the shiploader arm must be watched to ensure that the calculated airdraft is available in practice. If the shiploader has insufficient height to plumb the hold it may be necessary to alter the ballast. Alternatively, if the extra height need is small, it may be possible to allow access to shiploader by using ballast to list the ship towards the quay. If the ship is already fully ballasted the list should be created by discharging ballast from an after topside or double bottom tank to avoid any decrease of the forward mean draft. As soon as sufficient cargo has been loaded to achieve the required increase in draft, ballast should be used to bring the ship upright again.

Air draft is unlikely to be a problem in those bulk carriers which are provided with extra holds which can be ballasted in port. Where necessary such holds can be ballasted in sheltered waters before berthing to ensure that the ship's air draft is sufficiently low.

Any contact between ship and shiploader should be avoided as it is likely to lead to damage to one or both. Contact is most likely if the shiploader is left unattended whilst the ship moves as a result of swell, rising tide, ballast changes, slack moorings or the shifting of the ship to a new loading position.

The OOW must regularly check that the loading is continuing in accordance with the loading programme. Each pour must be loaded into the correct hold and into the correct position in that hold. The latter requirement is often achieved by-ensuring that the loader is aligned and remains aligned, say, with a white mark painted on the hatch coaming. On smaller bulkers with long holds the chief mate may have planned a different cargo distribution, requiring the cargo to be poured in another position-e.g., '2 metres forward of the mark'-and such instructions must be strictly followed.

It is also necessary to ensure that the correct cargo is being loaded. If the loading programme calls for iron ore fines in No. 3 hold and iron ore pellets in No. 5 hold, the OOW must ensure that the cargo being loaded in No. 3 does look like fines, not pellets. From time to time during the pour he must confirm that the cargo continues to have the same appearance and that there are no signs of contamination, or of excessive moisture.

The method of loading must be kept under survey and the ship's requirements must be enforced. If the ship is to be kept upright and all cargo is to be poured amidships, the shiploader operator must be reminded as necessary of the requirement. If the cargo is to be spout trimmed in the hold involving some listing of the ship first one way and then the other, the operator must be warned if he exceeds an acceptable amount of list. When a list develops as a result of uneven deballasting, the shiploader operator must be informed so that he does not try to eliminate it with cargo. Some bulk carriers are fitted with indicator lights on the bridge wings. For example, a row of lights, green to starboard and red to port, with a single white light amidships, may be fitted. When the ship is listed 2° to starboard two green lights will be lit. When indicators of this sort are available it may be necessary to bring them to the attention of the operator of the shiploader.

If the cargo is not evenly distributed in each hold-if the ship is kept upright by balancing the excess cargo on the starboard side of one hold with the excess cargo on the port side of another hold-the ship will be twisted and may suffer serious structural damage. It is essential that a ship which develops a list because there is too much cargo to starboard in No.2 hold is brought upright with cargo poured to port in the same hold. The ship should be upright at the completion of each pour.

The OOW will find it useful to have a reasonable idea of the loading rate. The time taken for the first pour will provide an indication of the rate in tonnes/hour. This can be checked against whatever rate the loading foreman or ship's agent has predicted. A slower rate than that predicted will be unsurprising since it is common to quote the best rate rather than the average rate. A faster rate than that forecast needs careful examination to confirm that it is correct and to consider its effect upon the rest of the loading/ deballasting programme. If loading continues at this rate, will the deballasting be able to keep up?

It will also be useful to observe whether the loading rate is a steady or a fluctuating one. That can often be determined by watching the flow of cargo from the spout or by observing the method of delivery of the cargo to the loading conveyor. Once the loading rate and any variations in it have been observed, it can be used to predict the time when each pour will finish. Pours which finish unexpectedly early or continue excessively should be carefully checked to confirm that the correct tonnage has been delivered.

The quantity of cargo loaded in each pour must be monitored as far as possible. A useful check can be obtained by taking a set of draft readings and checking the soundings of the working ballast tanks when the loader moves from one loading position to the next. Provided that the readings can be obtained quickly whilst loading is stopped, the results can be studied after loading has resumed and should be in good agreement with the values shown in the loading programme. If they are not in good agreement, there must be a mistake in the tonnage loaded, the quantity of ballast discharged or the loading/deballasting programme and it will be a matter of urgency to recheck everything and find the mistake.

Most bulk carrier officers know of one or two occasions in which serious errors in loading have occurred—when a hold has been overloaded by as much as 1,000 tonnes and the ship has finished up excessively trimmed by die stern or, even worse, by the head. It is very difficult for such errors to occur if the OOW is thoroughly alert and regularly checks the draft readings. Errors of this sort sometimes occur when officers are inexperienced and find themselves with too many problems to solve. On other occasions they occur when officers believe that everything is going well and their conscientious supervision is unnecessary. There is never a good excuse for overloading: draft readings, carefully taken, will always show the tonnage loaded and provide warning of possible overloading.

Deballasting must be monitored: Aboard many bulk carriers the deck OOW will personally implement the deballasting programme by operation of the appropriate control switches at a ballast control station. On other vessels the deballasting will be carried out by engineroom personnel on instructions from the OOW. In both cases it is good practice for the OOW to satisfy himself by direct observation that the deballasting is proceeding and a flow of air into the airpipe on deck provides a clear sign that ballast is being removed from the correct tank. Before deballasting starts the OOW or someone assisting him must where necessary ensure that airpipe caps (on older vessels) and manual valves (for forepeak tanks) have been physically opened.

As the loading continues, the OOW must check regularly to ensure that the deballasting continues without problem, a problem being anything which prevents maximum discharge from both pumps. First warning of a problem in deballasting may be the ship listing as a port tank pumps out whilst a starboard one fails to do so or vice versa. The pump gauges should be watched, and will provide a similar warning. A normal reading on the amp meter shows the pump is pumping and this can be confirmed by a normal reading on the discharge pressure gauge.

By itself, evidence that the pumps are pumping efficiently is not sufficient to guarantee that the deballasting is going well. Mistakes do occur and equipment does fail. It is essential to make regular checks by sounding or by observing the flow of air into the airpipe to confirm that the ballast is being drawn from the correct tank. Direct manual soundings of ballast tanks must be taken with sounding rod or steel sounding tape, particularly as the tank approaches empty, to check how much ballast remains and whether the tank has been properly drained.

As the deballasting continues, the OOW (if he is directly responsible for the pump controls) will have to adjust them as necessary to maintain optimum discharge rate as per the makers' instructions. On a large vessel-say, a Cape-sized bulker-the ballast pump controls are likely to require checking and adjustment at intervals of about 30 minutes, a frequency which increases in smaller vessels.

Deballasting of a compartment normally continues until the ballast pump finally loses suction with only a small sounding (0-30 cm) remaining in the tank at that time. Stripping is the process of discharging as much as possible of the final small tonnage of ballast which remains in the tank. If the ship is equipped with a separate stripping pump or eductor, that will be used to continue the discharge of any remaining tonnage of ballast in the compartment with the OOW monitoring the sounding in the tank. If there is no separate machinery for stripping, a further attempt will be made to reduce the strippings remaining when trim and list conditions are most favourable.

Work of crew members must be super-vised: The OOW must be prepared to organise and supervise the work of the crew when they are engaged in cargo-related work, particularly if they are required for the cleaning and preparing for loading of ballast holds and for the shifting of the ship from one position of loading to another. To ensure that no time is lost unnecessarily the OOW must co-ordinate the work of the crew with the deballasting and the loading, and must ensure that the crew members are kept informed of the programme and any adjustment to its timing. For example, the crew must be kept informed of any changes to the anticipated time when the ballast hold will be nearly empty and ready for cleaning.

As loading progresses and the loading of some holds is completed, the OOW will inform the crew when each hold is ready to be secured for sea. As the securing proceeds he will supervise it as necessary to ensure that the work is done correctly and with the required degree of thoroughness. Particular emphasis must be placed on the thorough cleaning of coamings and hatch drain channels.

Liaison with the loading foreman: Liaison must be maintained with the loading foreman to ensure that a good understanding is maintained between shore and ship personnel. The chief mate will normally take the responsibility for informing the loading foreman if deballasting or hold cleaning is behind schedule and an interruption in loading is required. It will be the duty of the OOW to keep the chief mate informed so that he can act in good time to arrange for an interruption in loading.

In the few ports where ships are moored with shore lines on shore winches and where the ship can be shifted along the berth by shore personnel, it is essential that the OOW is always informed before the ship is shifted.

Damage to the ship: Damage to the ship whilst loading is uncommon, but can occur as a result of contact between the shiploader arm and the ship's structure or as a result of careless loading. For example, the tanktop can be damaged by the pouring of pig iron on to the unprotected tanktop. Wherever possible the OOW should anticipate the possibility of damage and take steps to prevent it. When damage occurs the details must be noted and the stevedores must be held responsible by a written notice. Normally it will be the responsibility of the OOW to pass the details of the incident promptly to the chief mate so that the latter can serve the notice on the stevedores.

Damage to the cargo: Damage to the cargo or loss of cargo through spillage whilst loading is a possibility and should be treated in the same manner as damage to the ship. Damage should be anticipated and prevented where possible. When it occurs the details should be noted and promptly passed to the chief mate. If damage or spillage continues to occur it may be necessary to stop loading until better methods can be introduced.

Loading with ship's gear: When cargo is loaded with the ship's cargo-handling gear, a high level of alertness is required of the ship's officers. They must ensure that the equipment is properly used. Where necessary they must insist that winch or crane drivers from ashore follow the ship's rules for safe operation. They must also observe the equipment in operation and inspect it frequently to ensure that it remains in good working order at all times.

Moorings must be tended: The tending of moorings is necessary to ensure that the ship remains firmly alongside in position, despite the disturbing effects of loading of cargo, discharge of ballast, passing of other shipping, or change in level of tide, rate of current or strength or direction of wind.

If experienced seamen are on duty and the ship is well equipped with mooring gear, the duties of the OOW will consist of little more than ensuring that the tending of the lines is effected as required. But if the crew are inexperienced, the mooring equipment is inadequate, the berth is a difficult one or the conditions are exceptional, the work will require much of the officer's attention and he will have to be ready to decide when to initiate action such as putting out additional lines or calling the chief mate.

Means of access must be tended: The gangway or accommodation ladder will be subject to all the same disturbing factors as will the moorings and must receive all the attention required to ensure that it remains safe and in compliance with the regulations throughout the vessel's stay in port. This is a task which requires continuous attention if loading rates are high and tidal range is large.

Pollution avoidance: Pollution must be avoided. This requires the OOW to be alert to prevent any overflow of oil on deck or overside and to prevent any discharge of ballast where harm can be done. Pollution from the ship's domestic garbage and from hold sweepings, from discharge of contaminated bilge water, and by discharge of thick smoke from the funnel must also be avoided. Pollution by dust from the cargo can also be a problem and is one abouf which the terminal operators can be expected to give advice.

Weather must be observed and recorded: The basic weather data (wind direction and force, barometric pressure, temperature, amount of cloud, and description of weather-e.g., 'heavy rain', snow showers', 'fair') must be recorded at least three times daily, and are best recorded at the end of the watch of each OOW. In addition humidity readings should be recorded when the cargo is one which requires ventilation. More frequent weather reports should be recorded when the weather is bad and when it interferes with cargo work or threatens to cause damage to the cargo. Times of starting and stopping of rain must be recorded to allow the master to verify the statement of facts which may be significant for the laytime calculation.

The role of the OOW with respect to weather is far from being a passive one. When he observes the weather he must consider its effect upon the ship and cargo and must have no hesitation in taking action if the possibility of damage to ship or cargo exists. With some cargoes and in some ports the shore personnel may enforce sensible rules to protect the cargo and the loading process when adverse weather occurs, but it is never prudent for the OOW to rely upon anyone else to take the necessary action.

Loading must be stopped and the hatches closed if it starts to rain or even if it threatens to start to rain or snow upon a cargo, such as chemical fertiliser or grain, which can be harmed by water. If the cargo is being loaded from a stockpile which is in the open and if the permitted range of moisture content is large, then some rain during loading is unlikely to be critical, although this must be reconsidered if the rain is prolonged and heavy. The IMO *Bulk Cargo Guide* provides advice on measuring the moisture content of bulk cargoes.

If the loading foreman insists upon continuing to load during adverse weather when the master considers that loading should stop then company policy should be followed. This may call for a standard letter of protest to be issued, holding the shippers liable for any damage consequent upon loading during rain, or the master may be instructed to insist that a responsible person signs a standard letter of indemnity provided by his owners. If no satisfactory response is received the hatches must be closed. The decision as to what to do if it rains is best taken and agreed between all the parties before the rain occurs, when the vessel first arrives in port.

Loading may be stopped by shore personnel if high winds or fog interfere with the process, although problems are more likely during discharge. Furthermore, there are ports where loading in high winds from certain directions is prohibited because of the unacceptable quantities of cargo dust which are blown over residential housing.

Maintenance of *full written records:* *The OOW must maintain a full and accurate written record of all the events* which occur and *the readings* which are obtained during his period of duty. This information will be recorded in the port log, with the significant items being transferred to the deck log book. Whilst this topic is fully discussed in Chapter 3, it is worth repeating that a written record should be kept of:

- Times of commencing and stopping loading, and tonnages loaded as calculated by ship and shore.
- Times of transferring loading operations to another hold.
- Reasons for interruptions in loading or deballasting.
- Times of starting and stopping ballast pumps.
- Times of opening and closing ballast tank valves.
- Values and times of soundings obtained and tonnages remaining in each ballast tank.
- Values of ballast pump amp meter and discharge pressure readings at regular intervals.
- Values of draft readings obtained.
- Times of shifting ship.
- Times of start and end of surveys, names of surveyors, results of surveys.
- Times of bunkering fuel and water and tonnages taken.
- Details of any damage to ship or cargo.
- Weather observations at regular intervals, at least three times daily, but preferably every four hours.

Chief mate's role during loading

Draft survey: Before the start of loading the chief mate will normally undertake a draft survey. If an independent surveyor has been appointed the chief mate will accompany him on his survey, agree soundings and draft readings with him and then complete a separate set of calculations before comparing the final results with the surveyor. If no surveyor has been appointed the chief mate will simply take his own readings and complete his own calculations. Similar procedures will be followed on completion of loading.

Instructing junior officers: It is the chief mate who normally prepares the ship's loading/deballasting plan, and who is answerable to the master for its implementation. The chief mate will have supervised the cleaning and preparation of the holds and will normally take personal charge of any of the more critical steps in the loading programme. The second and third mates will be provided by the chief mate with copies of the loading/deballasting plan and will be instructed by the chief mate as to his requirements. If there are any special matters to which he wants to draw particular attention, the chief mate will be well advised to put them in writing. When in writing they are available to the OOW for further reference and study as the loading progresses.

Commencement of loading: The chief mate will normally be in attendance at the commencement of loading to ensure that a swift response can be made to any unexpected problems which occur. He will double-check that the loader can plumb the hold and that the cargo is the correct product being loaded in the intended position.

Monitoring of tonnages delivered: Problems can be *expected if the tonnages of cargo delivered by the shore installation are inaccurate. Unfortunately, shore personnel are not always certain of the accuracy of their* measuring equipment or honest in informing the ship of the reliability of the tonnages loaded. When possible it is prudent to make an accurate check of the tonnages loaded at intervals during the loading, and this is something that the chief mate should try to do by undertaking informal draft surveys from time to time, without interrupting loading.

Such surveys are useless unless the precise ballast condition is known, so they are best undertaken at the end of a stage in the deballasting when a full and up-to-the-minute set of soundings of any working tanks can be obtained at the same time as a full set of draft readings at a time when loading is interrupted and the shiploader is moving from one position to another. This informal survey is less important than an actual draft survey, so it is acceptable to use earlier soundings for ballast tanks which have not been pumped in the meantime.

With the information obtained from the informal draft surveys, the chief mate can calculate whether the shiploader is loading the planned tonnages or whether it appears to be loading too much or too little. On the assumption that the errors are consistent a percentage error can be calculated. If the figure is significant (and errors of up to 10 per cent have been reported on occasion) it can be used to amend the quantities required for the tonnages in each pour.

Departure from the loading plan: Quite often it happens that the loading and deballasting cannot follow the intended programme exactly. The chief mate should be informed when that occurs and may be able to adjust the loading/deballasting plan to take account of the new circumstances. This is only acceptable provided that he satisfies himself that the new plan remains within any limits imposed by the classification society.

It may be necessary to stop the loading if problems occur. This is a decision which the chief mate will normally take, perhaps after consultation with the master. Any interruption in loading is an important matter, which may cost owners or charterers money, so it is essential that the information provided by the ship is clear and unambiguous. It must be made absolutely clear if the ship is ordering a stop in loading or is merely giving advance warning that a stop may be required. It is also most important that any order to stop should be given in writing and should be claused 'due to failure of shore loader to keep to master's load plan' if the problem has indeed been caused by a failure of the shore installation and not of the ship. The reason for the stop and where possible the duration of the stop should be stated, and similar clear information should be provided when loading is to resume.

Final stripping of ballast tanks: The chief mate will normally take the opportunity at a time when the main deballasting is complete and the ship has a good stern trim, to satisfy himself that all the ballast tanks have been stripped to the fullest extent possible. This is an opportunity for him to use his experience to pump out a further tonnage of stoppings, thereby enabling the ship to lift a corresponding additional tonnage of cargo. The final soundings to which the strippings in the ballast tanks are reduced should be carefully recorded for inspection by any independent draft surveyor. Soundings obtained when the ship has a substantial stern trim and properly corrected for that trim will provide a measurement of the contents remaining which may be more accurate that later soundings taken when the vessel is trimmed even keel prior to sailing.

Trimming pours: The chief mate will calculate the quantities required for the trimming pours when he has obtained a full set of draft readings. To speed the process and to minimise the interruption in loading he may rely upon officers with VHF handsets to report some of the draft readings to him. The tonnages required for the trimming pours and the holds in which they are to be loaded will normally be passed to the loading foreman in writing, to avoid misunderstanding.

Topping off of holds: When the ship is loading a low-density cargo such as coke or grain, where the holds have to be completely filled, the chief mate will try to view the completion of each hold to satisfy himself that it has been entirely filled and that no space has been lost. Where a cargo requires trimming to provide a level stow or to ensure the maximum tonnage loaded, the chief mate should satisfy himself that the work has been properly done. Where a hold is part-filled on completion of loading a low-density cargo he may wish to observe the ullage or to measure or estimate the space remaining. When the space remaining is known the space used can be calculated, permitting an accurate calculation of the final stowage factor for the cargo.

Special requirements for particular cargoes: Many bulk cargoes require special attention. The lashing of steel cargoes and of timber deck cargoes, the separation of small parcels of bulk cargo, and the protection of chemical fertilizers from condensation require particular supervision, but no attempt has been made to deal with such matters here. The general point is that whenever the cargo requires special attention the chief mate will be actively involved, either by his presence in person or by the detailed instructions that he gives to his junior officers.

Damage claims: It is essential that stevedores are warned immediately when they have caused or seem likely to cause damage to the ship or cargo. The chief mate should regularly emphasise the importance of this to his junior officers and should ensure that they issue the appropriate warnings, and/or report to him immediately, when damage occurs or is likely to occur. When damage occurs the chief mate will probbably speak to the stevedores immediately to ensure that they are aware of the matter and should always follow this up immediately with a written notice (which can be a standard stevedores' damage form, or cargo damage form) when damage has occurred.

Securing for sea: The chief mate will superintend the securing of the ship for sea, rechecking for himself where necessary the work of the crew as supervised by the officers of the watch. In some trades, hatch covers and accesses must be sealed by an official, who issues an appropriate certificate (Appendix 14.23). (Some grain cargoes are fumigated on completion of loading, a process which is described in Chapter 21).

Master's role

When provided with competent officers, the master can expect that his involvement with loading a familiar cargo will be limited to the receiving of regular reports from the chief mate as to how the work is progressing and the offering of advice where appropriate.

When the cargo is more unusual or when the officers are inexperienced or unreliable, the master will find it necessary to monitor their work more closely and to undertake or recheck some of the more critical duties normally undertaken by the chief mate.

On occasions it may happen that a problem arises with the loading which is outside the master's experience. For example, he may be assured that a procedure to which he objects is 'normal practice' in the port. In such circumstances the master should not hesitate to stop the loading if necessary and to consult his owners and/or charterers. They have a strong interest in the safe carriage of the cargo and will expect to be informed and consulted when doubt arises.

Shifting ship by warping

Shifting ship by warping is a procedure which is rarely required in many sectors of modern shipping, but which continues to be relatively common in the dry bulk trades. When the loader is fixed or limited in its movement, the ship must be moved to place each hold below the loader in turn. When the ship is too large for the berth and overlaps its ends, she must be moved to allow the loading or discharging of the end holds. In addition, bulkers are sometimes required to move along the quay from one berth to another.

Mini-bulkers in the European trades obtain considerable experience of shifting ship. On average they visit 50 loading ports a year. At least half of those ports are likely to be fitted with fixed loaders where the loading normally requires four shift-ships per loading.

Handy-sized bulkers are required to shift berth or to shift within the berth at many loading and discharging ports, and Panamax and Cape-sized bulkers are also occasionally required to shift-ship within the berth.

The ability to shift-ship efficiently is a requirement in the bulk trades, but sometimes presents difficulties. If experience is lacking it is well worthwhile to make careful preparations and to ensure that a full mooring party is available aboard ship. There are two distinct and different warping operations, the first being a move within the limits of the berth with mooring ropes remaining on the same bollards, and the second being a move along the quay with mooring ropes transferred to new bollards.

Warping within the limits of the berth: Warping within the limits of the berth (called for convenience here a Type 1 shift) is normally considered to be an undemanding routine operation. On many bulkers, particularly smaller ones, the manoeuvre is conducted by the duty officer assisted by crew members without master and perhaps without chief mate being in attendance. No pilot, no tugs and no main engines are normally used.

It would be expensive and time-consuming to use a mooring gang for such a manoeuvre, which must be repeated several times during a ship's stay. Normally no mooring gang is used and the mooring lines remain on the same bollards throughout the duration of the ship's stay. To permit the ship to move back and forward along the length of the berth, at least one rope at each end of the ship must extend well beyond the ship's extreme positions and the forward and after springs must be secured at the centre of the berth. A suitable layout of moorings for use with a fixed loader is shown in Fig. 11.12. Where the loader is mobile but the ship is too long for the berth, the distance to shift will be less and the ropes need not extend so far.

Many ships have sufficient manpower and deck machinery to allow them to control no more than four ropes, two forward and two aft, at a time. Before the start of the manoeuvre, one rope leading well forward and one leading well aft must be chosen on the forecastle head and a similar pair of ropes must be chosen on the poop. The two ropes which have to be hauled must be led to winches or capstans, or will be on powered reels, allowing them to be hauled or slacked as required. The two ropes which must be slacked to allow the ship to move can also be led to winches if manpower permits or can be slacked from the bitts. The remaining ropes must be left slack, hanging down into the water.

To warp the ship ahead the rope which leads ahead from the poop (the after spring) must be hauled. The two ropes leading aft must be slacked. The slack on the headrope must be picked up as the ship moves ahead, but the headrope must not be hauled (Fig. 12.1). If the headrope is hauled as a ship moves ahead the bows will be pulled towards the quay and the headrope will hold the ship against the quay. She is said to be bowsed in, and stops moving ahead (Fig. 12.2). The same difficulty occurs if the stern ropes are hauled when the ship is moving astern. Bowsing the ship in is an easy mistake to make, partly because those positioned in the bows and stern do not always have a good view of the ship's alignment. It must be avoided, because the ship cannot shift when bowsed in.

The shift-ship manoeuvre may be conducted by the OOW located with a walkie-talkie radio on the forecastle head or beside the next hold to be loaded, where he can confirm that the ship has been positioned correctly. This arrangement will work when all the members of the mooring parties are experienced, but it is better to direct operations from the bridge, which gives a better overall view, if the mooring parties are inexperienced.

Warping from one berth to the next: Warping from one berth to the next (a Type 2 shift) is generally considered to be more hazardous than shifting ship within the berth. A failure to transfer the ropes competently could result in contact with the quay being lost at one end of the ship and the bow or stern swinging out into the harbour. Normally the master will conduct the manoeuvre, assisted by all the officers and full mooring parties on forecastle head and poop. A mooring gang will assist on the quay. There will be no pilot, no tugs and no main engines, except when the weather conditions are difficult.

Warping ahead from one berth to the next is conducted as follows in calm conditions or light winds from anywhere but onshore:

- Single up to a headrope and a spring forward and a sternrope and a spring aft, with the headrope and the after spring led well forward.
- Take the remaining lines inboard.
- Slack down forward spring and sternrope. Heave away on after spring. Pick up the slack on the headrope.
- Mooring men carry the ends of the two slack ropes along the quay, with just a short length outboard, the men walking abreast the fairlead.
- As the headrope and after spring are reduced to short lengths, the other two ropes are carried well ahead by the mooring men and the process of hauling the ship ahead is repeated.

The most serious problem met with this process is when the mooring men have strong views on how the operation should be conducted and those views do not coincide with those of the master. Mooring men who refuse to put the rope on the bollard when it is necessary to check the ship's motion can cause havoc with a shift!

If winds are strong, a Type 2 shift is achieved by making a succession of Type 1 shifts, with several ropes carried forward and secured in positions further ahead before the commencement of each shift.

Warping-general remarks: If it is necessary to alter the vessel's alignment as she is being warped along the quay, one of the ropes which is being slacked must be held (Type 1 shift) or one of the ropes which is being carried along must be put on a bollard and set taut (Type 2 shift). This is a skilled operation requiring judgement and experience-if too much weight is used the ship will sheer more violently than intended.

When a ship has started to move along the berth impelled by heaving on a spring with all other ropes just picking up the slack or paying out easily, a single mishandled rope with the weight applied at the wrong moment can cause the ship to sheer violently and spoil the whole manoeuvre.

Often the man at the controls of the winch, windlass or powered reel cannot see that part of the rope he is controlling which lies beyond the fairlead and does not know if it is slack or taut, although he can see if it is excessively taut. He is dependent upon orders or hand signals from the officer.

If a ship moves off the quayside during a shift-ship the process becomes increasingly hazardous because: the bow can swing in to the quay, with damage to the bulb or to the quay; the stern can swing in to the quay, with damage to the rudder, propeller or quay; the scopes of rope become longer and more dangerous to handle; and there is increased danger of reaching the end of a rope. For all these reasons a seaman's instinct and training condition him to keep the ship alongside during a shift-ship, and to shift at slow speed.

On many ships the hauling power of the windlasses on the forecastle head is greater than that of the winches on the poop. As a consequence, when a ship has to be hauled alongside from a position some distance off the berth difficulty is experienced in bringing the stern alongside, unless the main engines and/or tug are available. Even when eight or 12 ropes are on powered reels, it is unlikely that the officers in charge at the bows and the stern can exercise effective simultaneous control over more than about three ropes at each end.

As the length of rope outside the fairlead increases, so its elasticity increases. This makes it increasingly likely to surge on the winch drum end. When it surges it is likely to snatch itself out of the hands of the man who is controlling it on the drum end. This can cause injuries, and can lead to the remainder of the rope disappearing over the ship's side. When shifting ship long scopes of rope are hazardous, but are sometimes unavoidable.

A bulk carrier in ballast presents a large profile to a beam wind. The effect of the accommodation block at her stern is to make the stern fall off the wind. Adverse weather makes a shift-ship operation more difficult. A strong offshore wind is the most difficult condition in which to shift ship. It is also the most unusual. The ship is often sheltered from offshore winds by buildings or high land and even if this is not so winds off the land are less strong than winds from the sea because of the greater frictional resistance they meet.

Safety during cargo working

No-one should be allowed to stand or pass beneath the path of the cargo. Anyone passing along the deck should use the side opposite to that on which the cargo handling gear is working. It is good practice to rope-off the working side of the deck and to display 'NO ENTRY signs.

The gangway or accommodation ladder should be clear of the cargo working area if at all possible. The design of some ships and the positions of their accommodation ladders make this guideline impossible to follow.

Hard hats should be worn on deck. Goggles and dust filter masks should be worn when the cargo is dusty and requires these precautions.

A hold should never be entered when cargo is being worked except with the authority of the duty officer and the knowledge of the signaller for the cargo working equipment. Extra care must be taken when slippery cargo residues are on the deck.

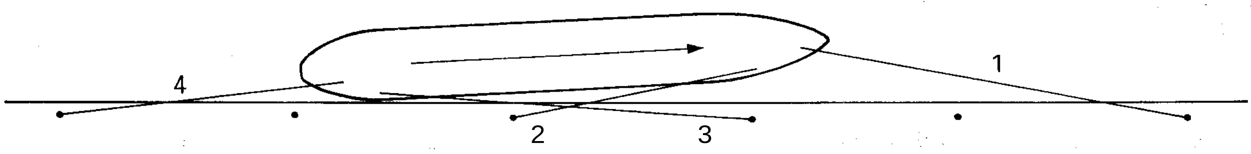
Hatch covers, whether open or closed, must always be secured so that they cannot roll in the event of a change in trim or list. Stevedores must be required to observe the same standards of safety as are required of ships' personnel. (The subject of safety is discussed more fully in Chapter 21.)

Sources

22. *Code of Safe Practice for Solid Bulk Cargoes.* International Maritime Organization. 1991.

85. *Ship Shore Safety Checklist.* International Chamber of Shipping. 1992.

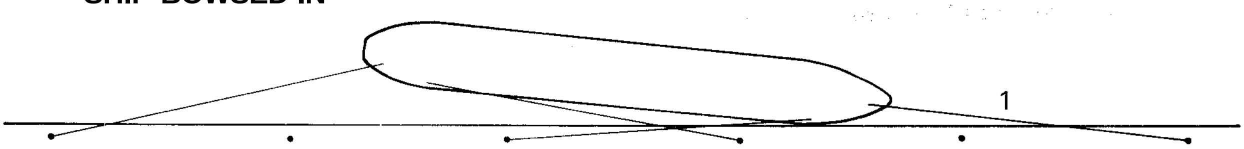
WARPING A SHIP AHEAD



1 Heave away easily on the headrope
2 Slack the forward spring
3 Heave away on the after spring
4 slack the sternrope

FIG 12.1 Provided that not too much weight is put on the headrope the bow will swing out slightly from the line of the quay, and the vessel will move ahead.

SHIP BOWSED-IN



1 Too much weight has been put on the headrope, pulling the forepart hard against the quay. In this position the hull will bind against the quay and the ship will refuse to move ahead

FIG 12.2

CHECKLIST-Duties of the officer of the watch in the loading port

- ☐ Study and understand the loading/deballasting programme.
- ☐ Ensure that all hatch covers are secured in position, whether open or shut, and cannot move by accident.
- ☐ Monitor the position of the loading arm, the loading sequence and the loading rate.
- ☐ Ensure that the correct cargo is loaded and cargo is in good condition.
- ☐ Keep any list within acceptable limits.
- ☐ Watch the draft to ensure that no overloading occurs.
- ☐ Monitor the deballasting to ensure that the best deballasting rate is maintained, problems are identified and corrected and maximum discharge of ballast is achieved.
- ☐ Co-ordinate and supervise the work of the crew to ensure efficiency in shifting of the ship, preparing ballast holds for loading, ensuring that ship's cargo gear is properly used and maintained in perfect condition, and securing of holds on completion.
- ☐ Keep the loading foreman informed of any developments, particularly of potential problems which may affect the loading.
- ☐ Note any possible causes of damage to ship or cargo and make every effort to prevent them.
- ☐ Note and record any damage to ship or cargo, and immediately pass details to the chief mate who will hold the stevedores responsible.
- ☐ Ensure moorings and means of access are tended as necessary.
- ☐ Prevent pollution from ballast, bilges, leakage of oil, garbage, cargo residues, funnel smoke and dust from cargo.
- ☐ Record full weather observations at least three times daily.
- ☐ Maintain full written records in the port log book and/or deck log book of all relevant events and data (items as detailed in the body of Chapter 12)
- ☐ Ensure that safe working procedures are followed.

Duties of the chief mate in the loading port

- ☐ Keep the master fully informed of progress in the loading and problems encountered.
- ☐ Distribute copies of the loading/deballasting plan to the loading foreman and the OOWs and ensure that it is understood.
- ☐ Give the OOWs additional written instructions regarding the loading if the circumstances require it.
- ☐ Keep the loading foreman informed regarding requirements for trimming, and possible causes of delay.
- ☐ Conduct ship's draft surveys or undertake draft surveys with an independent surveyor, when appointed.
- ☐ Monitor the commencement of loading, and act promptly to deal with any problems.
- ☐ Use informal draft surveys to monitor the tonnages delivered from time to time during loading.
- ☐ Supervise the final stripping of ballast tanks to ensure minimum ballast is retained.
- ☐ Calculate and supervise the trimming pours.
- ☐ Supervise the trimming of holds filled with low-density cargo to ensure that no space is lost.
- ☐ Supervise the trimming of holds when a level stow on completion has been stipulated.
- ☐ Check space remaining in part-filled holds for the calculation of stowage factors.
- ☐ Ensure that appropriate matters receive attention when particular cargoes are loaded.
- ☐ Provide verbal warning, quickly followed by written notice, to stevedores when the ship or the cargo is damaged.
- ☐ Ensure that the ship is properly secured for sea.
- ☐ Ensure that safe working procedures are followed.

CHAPTER 13

ESTABLISHING QUANTITY OF CARGO LOADED OR DISCHARGED

Methods of weighing bulk cargoes ashore, draft survey procedures, reasons for unexpected results

Shorebased methods of weighing

THE QUANTITY of cargo loaded aboard a bulk carrier can be measured in a variety of ways. The only method which directly involves the ship's personnel is the draft survey, but before considering this method in detail it is worth giving brief consideration to methods which may be used ashore. An understanding of these methods will help in assessing their reliability.

Electronic weighing of cargo on conveyor belt: The most common method of weighing used at modern loading terminals is the belt scale. This device continuously weighs the material on a selected length of the loading conveyor belt and multiplies this instantaneous weight value by the belt speed. The signal thus obtained is at all times proportional to the rate of material flow on the belt. Some commercial belt scales rely on magneto-elastic load cells. These devices rely upon the fact that the magnetic characteristics of steel are affected by mechanical stress.

The accuracy of a belt scale depends largely on the design of the conveyor and the way it is maintained. Provided that the conveyor conforms to specified basic requirements for design and operation, an accuracy of better than ±1 per cent of nominal capacity within the flow rate range is claimed by one manufacturer. Others state that belt weigher systems are capable of achieving an accuracy of up to ±0.1 per cent of true weight for capacities of 10,000 tonnes/hour and can be relied upon for an accuracy of 0.5 per cent. Accuracy is likely to diminish to ±1.0 per cent if the system is not used to capacity. Shipboard observers consider that inaccuracies rise on occasions as high as 10 per cent of true weight, presumably as a result of failure, or faulty calibration and maintenance.

Electronic weighing of cargo in grab: Cargo being discharged or loaded by grab can be weighed whilst in the grab by an electronic system. A computerised system can then record and total the tonnage handled. A working accuracy of 0.1 per cent is claimed by the manufacturers, but this is dependent upon the crane being motionless and in windless conditions when the weight is recorded. In practice these conditions are rarely met.

One manufacturer of electronic weighing systems for cargo in grabs uses a load cell mounted on the hook block. The magneto elastic load cell is built into a load-bearing part of the lifting system. When there is no load on the load cell, the magnetic flux lines around the windings do not influence each other. When the load cell is subjected to a load, the flux lines will cut each other and a voltage proportional to the applied force is induced in the secondary winding. The transducer which transmits the reading has low internal impedance and produces a powerful output signal, which is insensitive to interference, making the system reliable and accurate. The system is only suitable for use with grabs which are operated electro-hydraulically.

Weighing of trucks on weighbridge: For accuracy this method depends upon all trucks passing over the weighbridge with the results being accurately recorded and upon the tare weight (i.e., the unloaded weight) of each truck being accurately known. This is best achieved by weighing the unloaded vehicle on its return journey. Weighbridges have a potential accuracy of ±0.2 per cent. Most weighbridge systems can be indexed in the control house for any debris, water, ice or snow which may accumulate, but if the correct indexing is not applied (or is deliberately ignored or wrongly set) the weights recorded will be in error to a greater degree than would be expected by the manufacturers or the licencing authority.[14]

Automatic bulk grain weighers[14]: These machines are suitable for weighing grain and free-flowing materials fed from elevators, conveyor belts, storage hoppers or silos. They are produced in various sizes and can record weights in cycles from 30kg up to 5 tonnes. They can deliver at rates of up to 1,000 tonnes per hour. When this machinery is correctly installed and maintained by the manufacturers and regularly inspected by a reliable local regulatory authority an accuracy of ±0.1 per cent is to be anticipated. Such a degree of accuracy is a general requirement within the grain trade. It should however be stressed that the degree of accuracy attained depends upon the regularity of inspection, servicing and maintenance. It is reported[11] that some manufacturers are more realistic and suggest that operational accuracy is more like ±0.3 per cent.

Shorebased systems in general: At best, all the foregoing methods can be only as accurate as the design of the weighing equipment allows. At worst, if the equipment is not regularly calibrated and if not all cargo is weighed, the results may bear little relationship to reality.

Cargo which drops on to the deck or into the dock from partly closed grabs or which leaks out of insecure trucks can form a significant percentage of the total, and it is worthwhile keeping a record of occasions when this is a problem. Even cargo which blows away from open grabs, trucks or stockpiles represents a loss of weight and should be noted. Cargo residues which remain aboard will also not be included in outturn weight if measured ashore. In addition, such residues (if substantial) present a real practical disposal problem for the ship's small staff, unless the ship returns uncleaned for a further load of the same commodity.

The operations departments of shipping companies with ships engaged on regular trades receive separate cargo figures from shippers, receivers and ship and can over a period of time build up a reliable picture of the accuracy of cargo measurements. The masters of such ships are often told by their operations department 'It is our experience that the shore weight in this port is always 1 per cent high', or some such figure, and this can be a useful point of reference.

There is no doubt that the operators in the loading or discharge port quickly obtain a feel for the accuracy of the measurements they obtain. They may choose to disregard the protests of a single ship, but if they are told by a succession of ships of different owners and nationalities that their cargo totals are too high or too low, they will begin to accept that there is truth in the allegation. Persuading them to pass this information to future ships attending the berth is another matter. Often informal questions to the loading foreman produce more accurate and reliable statements of known errors than do enquiries directed to management, who are reluctant to admit to the shortcomings of their system.

Shore measurement can be useful, but the importance of independent measurements made by the ship cannot be too strongly emphasised. Mistakes are sometimes made by operators ashore or instruments develop faults, and some spectacular and embarrassing errors in loaded quantity have resulted from failure by ship's staff to take their own accurate independent measurements. It cannot be emphasised too strongly that the ship must make regular draft checks during loading to avoid ending up loaded too deeply. Two final pours must be reserved at the end of loading for accurate trimming and to achieve the intended draft.

Draft survey

The ship's method of determining the amount of cargo loaded is by means of draft surveys taken before and after the loading is carried out. With the data so obtained the ship's displacement (the volume and therefore the weight of water displaced by the ship) before and after loading can be calculated. In simple terms the increase in displacement after loading, adjusted for any change in weights such as ballast, equals the weight of cargo loaded.

The draft survey may be the method of measurement specified in the charterparty for deciding the quantity of cargo carried, in which case one or several surveyors are likely to be employed to carry out the survey. When the charterparty specifies that shore measurement is to be used for deciding the quantity of cargo carried, the master will still be expected to calculate a ship's figure to provide a check. It is in his interests to do so and to ensure that the results are as accurate as possible. In special cases, the surveyor will have the benefit of equipment and instruments not found aboard the normal bulk carrier, but in most instances the ship's master or officer with careful attention to accuracy and procedure can obtain results quite as good as those of the surveyor.

In this chapter the procedures for making draft surveys before and after loading, and for calculating the quantity of cargo loaded are described in general terms. For those who require it a complete displacement calculation, fully explained, is to be found at Appendix 10.X.I. In addition, the United Nations draft survey code[60] can be strongly recommended for the clarity and detail with which it describes good procedures, and for the well-designed survey forms which it provides.

Conditions for the commencement of survey

1. Vessel afloat.
2. No cargo being worked.
3. No ballast, fuel, fresh water, etc., being pumped or run.
4. No hatch covers being opened or closed.
5. No spares or stores being shipped or landed.
6. All ballast tanks full or empty.
7. Ship upright.
8. Little or no tide or current running.
9. Seas not unduly rough.
10. Temperature difference between sea water and ship's decks not excessive.

From the foregoing list, items 1 and 2 are essential, whilst items 3, 4 and 5 are equally important unless the ship is large and the tonnages involved are very small. For example, the loading, discharging or moving of stores or bunkers weighing no more than 5 tonnes would not be detectable aboard a Panamax-sized vessel but would have a measurable effect on the draft of a handy-sized vessel.

Subsequent calculations are simplified if ballast tanks are either empty or full (item 6). It is often suggested that ballast tanks should be pressed up and overflowed prior to survey, to demonstrate that they are full. If the ship possesses no trim corrections for the tank calibration tables, pressing up the tank may be the best option, but this method has its disadvantages. In some ports the overflow of ballast water on deck is prohibited. Even when overflowing is permitted it is possible for a tank to overflow without being completely filled. This problem occurs particularly with topside wing tanks, when the ship is heavily trimmed.

Most accurate results are likely to be obtained if the topside wing tanks are filled to just below upper deck level at the sounding pipe, and if the tonnage of ballast is then calculated using the tank calibrations to take account of sounding and trim. Use of a correction can be avoided if the vessel is upright when the survey is undertaken (item 7).

Items 8, 9 and 10 are beyond the powers of ship's staff to influence unless the time of the survey can be delayed, but they should be remembered, and strong current, rough seas or great temperature differences should be recorded in the survey remarks.

A strong current can lead to squat, which will affect the accuracy of both mean draft and trim. Rough seas will make accurate draft readings difficult or impossible to obtain, and a ship with decks heated by the sun at a time when the underwater body is relatively cool will be distorted, which will introduce inaccuracies into the stability data. Fortunately extreme examples of these problems are rarely found in practice, so that accurate results can usually be obtained.

Full set of draft readings: The first step in the survey is to obtain accurate readings of the six required drafts-namely, forward, amidships and aft on both port and starboard sides. An active person can obtain these readings easily with the help of a rope ladder on the outboard side if the vessel is small or medium sized, but for a large ship a launch or ship's boat is useful.

It is possible to obtain a good approximate reading of the drafts of a small ship from on deck, but this method will not be sufficiently accurate for the purposes of a draft survey because of the oblique angle at which the marks are then viewed. For illumination, a powerful torch or portable Aldis lamp may be required in conjunction with binoculars, as it may be necessary to read some drafts from a distance of 10 or 20 metres. Drafts are normally read to the nearest centimetre or half inch, any greater degree of accuracy being unrealistic.

When there is a substantial sea running, it is often easier to try to calculate the mid-point between the highest and lowest readings obtained over a period of several minutes or longer. Highest and lowest readings can be read from a weighted tape-for example, a sounding line-dangled overside close to the draft marks. It is useful to take the mean of readings obtained by several observers in these conditions.

Complete set of soundings: Next, soundings must be taken of all spaces including compartments such as cofferdams, chain lockers and void spaces in addition to all bilge and ballast spaces. There have been plenty of instances in which compartments which the ships' personnel thought were empty were found to be full.

Additional soundings of 'empty' tanks should where possible be obtained later during the course of loading or discharge, when the vessel has a good trim. If this is done, the sounding is less affected by minor errors and the calibration tables can be used to obtain a tonnage of remaining ballast which is much sensitive than when the ship is even keel as she is likely to be when fully laden. A surveyor will often accept these ship's figures if he can see during the draft survey that the ship's approach is professional.

A full set of fuel tank soundings should also be obtained, but this requirement is often avoided by simply obtaining from the chief engineer the total quantity of fuel aboard. If the purpose of the survey is to measure the quantity of cargo aboard it does not greatly matter whether or not this fuel total is accurate. The constant (described below) will absorb any inaccuracies in the fuel total as an automatic consequence of the routine deadweight calculations. The total weights aboard ship will be unchanged.

It is important that the quantity of fuel consumed and loaded between the initial and final draft surveys is accurately known. In many cases the in-port consumption will be no more than two or three tonnes and no bunkers will be loaded, so an accurate figure for fuel consumption presents no problems. In cases when this is not so, a full set of fuel soundings must be obtained. A full set of all soundings, including fuel soundings, is also required when the purpose of the draft survey is to obtain an accurate value for the constant.

The purpose of the set of soundings is to discover the volume and thereafter the weight of all liquids aboard the ship. It is good practice to note the reading on the rod/tape/line at the level of the sounding cap, too. Provided that the sounding to the cap is known or can be verified, a correct reading will show that the sounding pipe is not blocked-for example, by a broken link of a sounding rod or by mud. It will usually be found that similar tanks to port and starboard and along the length of the ship have soundings with the same total depth from the sounding cap: If any sounding gives unexpected or uncertain results it is necessary to recheck. If doubt remains and the compartment can be entered, this is often the quickest way of finding exactly what its contents are. Alternatively, it may be possible to sound or to ullage it through a different opening, such as an airpipe, to obtain a rough check on its contents.

Where soundings are taken with sounding rod or tape the signs of a suspect sounding are the failure of the rod to land cleanly on the striking plate, or a dirty rod without a definite waterline on it. The use of water finding paste will provide a clean waterline on a poor sounding line.

When a sounding is read from a gauge, the accuracy of the gauge should first be confirmed by ensuring that the reading is zero when the gauge is switched to 'null', or by obtaining the correct test readings when the gauge is switched to 'test'. Gauge readings are not considered sufficiently reliable for draft surveys and gauges should be used only as working instruments.

Density of water: The final measurements which are required at the time of the survey are measurements of the density (in air, not in a vacuum) of the water in which the ship is floating and of any ballast water carried aboard ship. Unfortunately, accurate measurements of density are more difficult to obtain and to interpret than many seafarers will realise. If traditional routines are followed it is quite likely that unsuitable hydrometers will be used to measure incorrect water samples.

If the water density is measured as 1.025 when it is actually 1.020, the error in calculated tonnage of cargo aboard a laden 65,000 tonne deadweight (75,000 displacement) Panamax bulk carrier will be 317 mt. Even 1.024 instead of 1.025 will result in an error of 63 mt in the calculated figure. Clearly, it is important to obtain an accurate density. Unfortunately this is not easy, for reasons explained below.

Water sampling: Harbours are often filled with water of different densities as a result of a mixture of sea water and fresh water from a river and this condition can vary with the state of the tide. When water of different densities is present, it tends to form layers, with the most fresh (least dense) water on the surface. A sample of water taken from the surface is unlikely to be typical of water over the full depth of the vessel and water density may also vary between different positions along the length of the ship. For best results it is necessary to obtain a number of samples, from at least three positions on the offshore side of the vessel and from a number of different depths. Several patterns of sampling bottle are available (see Chapter 22).

The problem of obtaining reliable water samples can be a real one, particularly for big ships at deep draft, but this is an extreme case quoted to draw attention to the problem. If, on the other hand, the port is wide open to the sea and if no rivers flow nearby, it is likely that the water density will be constant or nearly so over the full draft of the ship. In those circumstances a water sample taken from the surface will be adequate. Officers who are eager to build up an accurate set of measurements of the ship's constant will try to obtain careful measurements in places where the water is likely to be completely salt or completely fresh.

Density of ballast water: In addition to the density of sea water it is also necessary to measure the density of any ballast water carried aboard at the time of the survey. It is quite possible for the density of water within a ship's ballast tanks to vary from tank to tank if the tanks were filled at different stages of the tide or at different points on a river passage, so samples should be obtained from a number of tanks if accurate results are required. To take an extreme case, if the ship's full ballast is assumed to be salt water when it is actually fresh water the resulting error in the calculated full cargo lifted would be about 1.0 per cent.

Density measurement: The next problem arises with the hydrometer supplied to the ship to measure density. A great variety of instruments using an assortment of scales, units and standard temperatures are supplied to ships. In addition to the fact that hydrometers are manufactured in various parts of the world where different units are used, part of this confusion arises because there is really a need for two different ship's hydrometers, each for a different task.

Most ships are (or should be) provided with a leadline hydrometer which measures *specific gravity* (also known as relative density). The specific gravity of fresh water is 1.000, and that of salt water is 1.025. This number has no units-it is the ratio of the density of the measured water with the density of fresh water. The leadline hydrometer is intended for use in the calculation of fresh water allowance. It enables the ship's officer to calculate how much the leadline can be submerged in fresh or brackish water and for that purpose it provides a direct ratio between water of different densities.

Surprising as this statement will be to many, a leadline hydrometer is not suitable for the calculation of displacement unless a correction is applied. For an accurate calculation of the weight of water displaced by the vessel it is necessary to know the *apparent density in air* of the sea water, in kilograms/litre or equivalent units. Draft survey hydrometers made of glass and calibrated in these units have been available for some years but their use is not yet widespread. Their readings extend from 0.990 kg/1 to 1.040 kg/1.

Many ships carry a leadline hydrometer and few carry a draft survey hydrometer, so it is helpful to know that a reasonably accurate conversion of the reading taken from a leadline hydrometer can be made.[10]. If the hydrometer is marked with graduations *ofg/mgat* 15Cor *Spec. Grav. 15C/4Cthen* 0.0011 must be deducted for the reading obtained. If the hydrometer is marked with graduations of *Spec. Grav. 60F/60F* then 0.0020 must be deducted from the reading obtained.

Hydrometer Graduations	Correction to Apply	Example: Reading Obtained	Example: Corrected Reading
g/mg at 15C	-0.0011	1.023	**1.0219**
Spec. Grav. 15C/4C	-0.0011	1.023	**1.0219**
Spec. Grav. 60F/60F	-0.0020	1.023	**1.021**

The corrected reading should be used for the calculation of displacement.

Calculation of the displacement: On completion of the readings and observations described above the calculation of displacement can be undertaken. The procedures and formulae used are given in full in Appendix 1O.X.I. They are also fully and clearly described in the UN code for draft surveys{Sup,60}, a detailed publication which provides much additional information and can be recommended to anyone who wishes to obtain a comprehensive knowledge of draft surveys for bulk cargoes.

Described below is the purpose of each step in the calculations. The numbering used refers to the relevant line in the Appendix.

- *(L23/26) Correction of the draft readings*
  The ship's stability data will have been compiled using drafts at standard positions-namely, at the ship's forward and after perpendiculars and at the ship's midlength between the perpendiculars. The ship's draft markings are not usually placed at the perpendiculars. If they do not coincide there will be a discrepancy between the draft as read, and the draft at the perpendicular, except when the ship is at an even keel (Fig. 13.1). The corrections, which may be obtained from the ship's tables or from formulae must be subtracted from the observed reading to obtain the corrected reading when the ship is trimmed by the stern and the draft markings are located abaft the perpendicular. Formulae should be used in preference to the ship's tables to avoid the risk of errors in interpolation.
- *(L32) Correction for hull deformation: calculation of mean of mean, or quarter mean, draft*
  If a ship's hull is completely undeformed (i.e., not distorted) the midships draft will equal the mean of the forward and after drafts. In practice, this is rarely the case. The ship is normally either hogged (with the midships draft less than the mean of the forward and after drafts) or sagged (with the midships draft greater than the mean of the drafts at the extremities). A ship which is hogged will displace more than an undeformed ship at the same midships draft, whilst a ship which is sagged will displace less. The purpose of this correction is to take account of this fact.

  The formula for mean of mean draft (or quarter mean draft-an alternative name for the same calculation) assumes that a ship deforms in a parabolic fashion. This is not strictly correct, but is accepted as being a sufficiently good approximation for practical purposes and is used almost universally. The formula, when evaluated, gives a corrected mean draft with a value which takes account of hull deformation.

  (Alternative methods for correcting for hull deformation are: [a] use of ship's approved table of corrections: [b] integration of the transverse section areas representing the immersed portion of the hull as actually trimmed and deflected, using approved parabolic coefficients: and [c] correction related to the waterplane area with use of approved hog and sag correction factors. Whilst each of these methods is valid, and is described in the UN code

CORRECTIONS TO DRAFT FOR TRIM

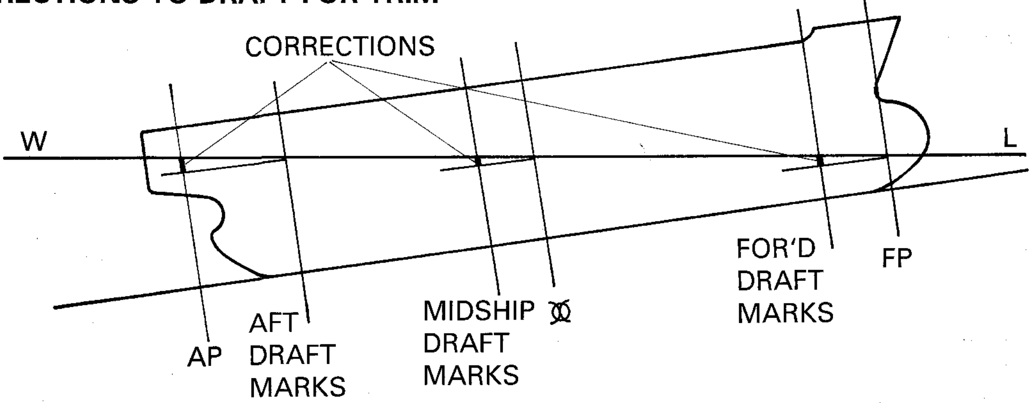
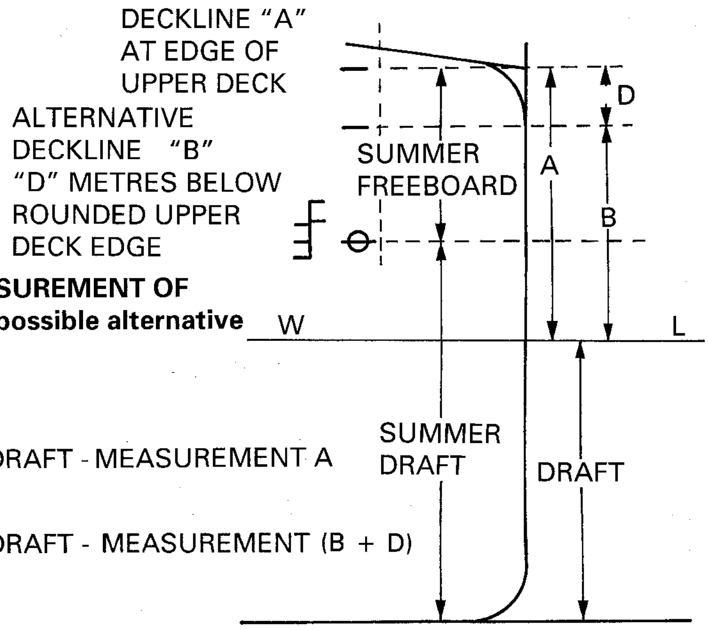


FIG 13.1

When the draft marks are not placed at the forward and after perpendiculars, and exactly at midships, the readings must be corrected to give the readings as they would be if taken at the perpendiculars and at midships.



MEASUREMENT OF DRAFT BY MEASUREMENT OF FREEBOARD, taking account of two possible alternative positions of the deckline

DRAFT =
SUMMER FREEBOARD + SUMMER DRAFT - MEASUREMENT A
OR
SUMMER FREEBOARD + SUMMER DRAFT - MEASUREMENT (B + D)

FIG 13.3

none is widely used in practice.)

- *(L33) Displacement (in tonnes)*
  Displacement is obtained from the ship's hydrostatic tables (stability data) entered with the corrected mean draft. This requires further corrections, described below.
- *(L39) First correction for ship trimmed (layer correction)*
  This correction is necessary because the longitudinal centre of flotation (LCF) about which the ship trims is not a fixed point and does not normally coincide with the ship's mid-length, the point for which the corrected mean draft is calculated. The correction is positive when the ship is trimmed by the stern, and the LCF is abaft midships. (For a loaded Panamax vessel-displacement 75,000 tonnes-with a trim of 1 metre the correction has a value of about 65 tonnes.)
- *(L46) Second correction for ship trimmed (form correction)*
  This correction is necessary when the trim is large to take account of inaccuracies which arise in the layer correction in these circumstances. This correction is always positive. (For a loaded Panamax vessel-displacement 75,000 tonnes-with a trim of 1 metre the correction will have a value of about 12 tonnes. If the trim is 2 metres the correction will be about 50 tonnes.)
- *Trim correction by ship's tables*
  It is quite likely that the ship's trim correction tables will be based upon the first correction, but will not take account of the second correction. This can be readily checked by working some examples by tables and by the formulae provided, to see whether the tables give a correction which equals the first correction or the sum of the two trim corrections. In addition, the use of tables permits errors of interpolation and the tables themselves may contain errors. It is advisable to calculate the trim corrections by formulae and to avoid the use of the tables except as a check.
- *(L52) Correction for ship listed*
  A ship when listed experiences a reduction in mean draft since the effect of the list is to increase her waterplane area and displacement, and to cause her to rise in the water. Therefore the correction is always positive to reflect the greater displacement which corresponds to the deeper draft when the ship is upright. (For a loaded

Panamax vessel-displacement 75,000 tonnes-with a list of about 3 degrees the correction has a value of about 15 tonnes.)

- *(L55) Density correction*
  When the ship is floating in water of a different density to that assumed in the ship's hydrostatic tables the displacement must be corrected for density. When the water is less dense (e.g., fresh water) the ship's displacement at any draft will be less. The hydrostatic tables for most ships are compiled for a density of 1.0250 mt/m^3 (equivalent to an SG of 1.0250), but occasionally other values such as 1.000 (fresh water) or 1.02518 (= 35 ft^3/long ton) are found.

Completion of the foregoing corrections provides the ship's true or actual displacement. When all known weights have been deducted from the displacement, the weight remaining will be that of an unknown quantity-for example, the cargo when the ship is loaded, or the constant when the ship is in ballast. Calculation of the constant normally precedes calculation of the cargo loaded.

Calculation of the constant: The 'constant' is the name commonly given to the unidentified weights and inaccuracies which remain when all listed weights have been deducted from the true displacement. It is called the constant because when it has been calculated with the ship empty of cargo it is assumed to be unchanged (i.e., constant) for the purposes of the calculations when the ship is loaded. Some people find it confusing that the constant is found to vary from voyage to voyage. This probably arises from differences in quantities in engineroom tanks and bilges, changes in the tonnage of stores and spares carried, and minor inaccuracies in the draft surveys.

No opportunity should be lost to recalculate the ship's constant as accurately as possible, and to maintain a full record of values obtained. If the ship's records are carefully and fully maintained they are more likely to be accepted and used by a surveyor when something goes inexplicably wrong with a draft survey and reobserving is no longer possible. A recommendation of the UN draft survey code[60] is that the ship should keep a record of all constants on a *Light Ship Correction Certificate* which should show date, place, constant in metric tonnes and signatures of chief mate and surveyor, with the surveyor's stamp. If this recommendation is followed, it will be important to ensure that the calculation is consistent and that the same items are always deducted from the displacement.

In practice, the weights which are separately itemised vary from ship to ship, surveyor to surveyor, owner to owner and time to time. Usually the itemised weights will include fuel oil, diesel oil, fresh water and ballast water. Sometimes stores and spares will also be separately listed, but they may alternatively be included in the constant. The ship's light weight (her weight as built before being stored or bunkered) will always be a separate item. Luboils may be a separate item, and other items such as ER water (water for engineroom purposes) can be itemised separately if convenient.

If the constant is to be calculated simply as part of the process of calculating the tonnage of cargo aboard, it will only be necessary to make accurate calculations of the ballast which will be discharged whilst the cargo is being loaded. Any inaccuracies in the values given to the other weights will be absorbed into the constant. If the constant is to be calculated as accurately as possible, then all the other weights must be calculated with care.

The soundings must be used with the ship's calibration tables to find the tonnage of water or fuel in each tank. Corrections must be applied to take account of trim. If no corrections are included in the tables themselves, it will be necessary to use a formula. (Appendix 13.2) to correct the sounding to an even keel value.

When using the calibration tables, ship's staff are well advised to look critically at them since they occasionally contain obvious errors. It has been known for similar double-bottom tanks to be provided with the same calibrations, despite the fact that in one tank the sounding pipe ran vertically down a bulkhead amidships, whilst in the other it followed the ship's side and sloped at an angle of 45° in way of the turn of the bilge. The procedure mentioned earlier of taking a reading of the sounding line at the level of the sounding cap would lead to the detection of this discrepancy.

The volume of water or fuel in each tank must be multiplied by the density (NB: the apparent density in air) of the liquid as measured to obtain the tonnage contained therein, and readers are reminded of the importance of accurate measurement of the density.

The ship's light weight is obtained from her stability information. It changes only if the ship's structure is modified. There is no easy way of measuring the weight of stores and spares carried aboard ship. This will vary with the size of ship and the nature of her trade, and will tend to increase as the ship grows older. An estimated figure will be used for this item, a figure probably based upon that used in past voyages.

Once all these weights have been calculated or estimated, and deducted from the true displacement, the weight which remains is the constant, a figure which can be expected to range from 30 or 40 tonnes aboard a relatively new mini-bulker of 3,000 tonnes deadweight to 300-400 tonnes for a Panamax bulk carrier. Actual values will vary substantially for individual ships, depending upon many factors which are examined in greater detail in Chapter 9 where the maximising of the tonnage of cargo lifted is discussed.

The constant will probably include the accumulation of paint on the ship's structure, the build up of mud in the ballast tanks, the increasing weight of stores, spares and equipment carried, the water in the engineroom bilges and the fuel in the engineroom settling and service tanks. It may also include ballast residues and luboil. The constant will also, because of the manner in which it is calculated, inevitably include tonnages to match any deliberate or accidental overestimates or underestimates in the itemised weights. If the figure for fuel bunkers is 50 tonnes too low, the constant will be 50 tonnes higher than it would otherwise be.

Calculation of the cargo loaded: Once the constant has been calculated, it is possible to list all the weights aboard the vessel on completion of the loading of her cargo. Some of the weight totals will have to be amended from those used at the start of loading. Almost all of the ballast will have been discharged and some fresh water and fuel will probably been consumed. Additional bunkers may have been loaded.

A second draft survey is undertaken and a new true displacement will be calculated. All the itemised weights, correctly updated, will be deducted from the displacement. The light ship weight, and the constant will be deducted. The tonnage remaining is the cargo tonnage by draft survey, often known as the ship's figure.

Possible sources of error

Occasionally it will be found that the results obtained from a draft survey are unexpected. The constant may be found to be much larger than the normal for that ship, or a negative constant may be calculated. The ship's figure for the tonnage of cargo lifted may differ from the shore figure by an unusually large amount. If the ship's officer and surveyor work independently, but compare figures at each stage of the calculation, then calculation errors are minimised. Since the discrepancy may be the result of a mistake in the draft readings or soundings, these should be rechecked, if still possible.

If the result remains unchanged it will be necessary to look further for an explanation. All the information used in the calculations must be studied to assess its reliability. Where possible data should be rechecked by a different method. It is useful to consider whether the discrepancy has occurred once only, or occurs every voyage. If it occurs every voyage, then it arises from data which are used every voyage. If it occurs once only, then it is more likely to be caused by something specific to that voyage.

Always investigate any substantial changes in the calculated value of the ship's constant. Accurate and reliable draft surveys are more difficult to achieve when a vessel has a large stern trim, such as may occur when a vessel has been partly deballasted to permit a quick loading. The master should hesitate to berth his vessel with an excessive trim if he knows this will make the draft survey less reliable and should use whatever means are available to persuade the terminal manager to accept his vessel with more ballast. The interests of ship and terminal do not always coincide, and the master should ensure that an accurate draft survey is made, which will enable him to produce the correct amount of cargo at the discharge port.

Examples

Vessel aground: A Panamax vessel was completing loading a cargo of iron ore in a West African port at 0300 hours with the final trimming pour being loaded in a forward hold. The chief mate was on the quay watching the forward draft. While loading continued the forward draft stopped increasing. Loading continued until the tonnage calculated for the trimming pour had been loaded. The final draft was found to be less than expected, with a trim by the stern. The explanation for this was not immediately realised and it was thought that there had been an error in the calculation of the trimming pour. Since departure from the port was governed by a limiting draft of 45 ft, ballast water was put into the forepeak tank to bring the vessel to an even keel, but the trim by the stern persisted. Finally, it was realised that the vessel must be aground forward and the ballast was pumped out. Fortunately for those involved the vessel refloated at high water, although the tidal range was small. When afloat she was found to be a little by the head and listed a little to starboard.

Grounding in the berth is a possibility where the bottom is mud or sand and has to be dredged, particularly if the port authority is inefficient. Partial grounding is also liable to occur on a shallow patch which may occur close to the quay, where cargo may have been spilt. If the vessel is aground on completion of loading the final draft and trim will be wrong. If the vessel grounds at an earlier stage-for example, at the time when the tonnages for the trimming pour are calculated-then the final draft and trim will be accurate if the vessel is afloat by that time, but they will not be the draft and trim intended.

Inaccurate draft marks: Following drydocking on a mini-bulker, the ship's figure for tonnage lifted was lower than expected for several voyages in succession. The draft marks were carefully measured from a dinghy and it was found that the upper port after draft marks (painted on the sloping surface of the stern) were several inches in error. The lower marks, cut into the sternpost, were easier to see and to verify and were used as a datum. The ship was ten years old, the hull was rusty and thickly coated with paint in the vicinity of the draft marks, and the original lines cut into the hull to mark the upper drafts were almost invisible.

Raised draft marks are unlikely to be wrong and inaccuracies in draft marks painted on the vertical or near vertical surfaces amidships and at the bows can easily be noticed. The after draft marks painted on a sloping surface are the only ones which are difficult to verify. Suspicions should be aroused if the draft readings suggest that the ship is twisted between midships and the stern. If the midship drafts are equal, port and starboard, but the after drafts suggest a list to one side, or vice versa, it is possible that the draft marks are incorrectly marked.

Deck line not placed at deck level: Where a ship has no draft marks amidships, the midship drafts are obtained by measuring the freeboard from the waterline to the top of the leadline, or deck line, with a steel sounding tape or tape measure. When the draft is light it is often easier to measure from the deck line, with one person descending to water level whilst the other takes the reading at deck level. Freeboard is normally converted to draft by adding the deepest summer draft to the summer freeboard, and then subtracting the measured freeboard. (Fig. 13.3) In some cases this will give a false draft.

On some ships-for example, those with a rounded deck edge-the deck line is likely to be located on the vertical ship's side, at a distance (d) below the freeboard deck. Distance d will be stated on the leadline certificate and in the ship's plans. In this case the midships draft is obtained by subtracting the measured freeboard, *plus d,* from the sum of the deepest summer draft and the summer freeboard.

Ballast retained by mistake: Ballast has on occasion been retained by mistake aboard a ship loading a deadweight cargo. This has occurred as a result of a misunderstanding at change of watch or as the result of a tank being refilled or part filled by mistake through a leaking ballast line or an open valve. If no draft surveyor is in attendance, and if ship's staff do not follow sound procedures, such an error may not be detected.

The soundings of all ballast tanks should be rechecked before the final trimming pours are calculated and loaded. If this procedure is followed without fail any remaining ballast will be detected and can be discharged before completion of loading.

When completing the discharge of ballast from a compartment the valve should be closed before the pump is stopped. If these operations are carried out in the reverse order water will gravitate back through the stopped pump and past the valve, until such time as the latter is fully closed.

When there is any possibility of a misunderstanding of orders about ballasting all orders should be given in writing and acknowledged with a timed signature.

Sources

7. Wolfram, J., B.Sc, PhD., C.Eng2, MRINA, 'Factors Affecting Draft Surveys'. *Work of the Nautical Surveyor.* The Nautical Institute, 1989.

8. Strange, J.L., PhD., MNI, 'Improving the Accuracy of Draft Surveys'. *Work of the Nautical Surveyor.* The Nautical Institute, 1989.

9. Turner, J.E., C.Eng, B.Sc, M.Sc, 'Hog/Sag and Trim Corrections for Draft Surveys'. *Work of the Nautical Surveyor.* The Nautical Institute, 1989.

10. Stokoe, E., 'Weight/Volume Relationships Required for Draft Survey Calculations'. *Work of the Nautical Surveyor.* The Nautical Institute, 1989.

11. Parker, Captain K., MNI, 'Measurement of Bulk Cargoes'. *The Mariner and the Maritime Law.* The Nautical Institute North East Branch, November 1990.

12. Stokoe, E., 'Apparent Density, Density and SG of Sea Water: What is the Difference?'. Letter to *Seaways* October 1990.

13 Durham, C.F., FRMetS, AMIAM, MNI, *Marine Surveys.* Fairplay Publications, 1982.

14. 'The Measurement of Bulk Cargoes'. *Carefully to Carry,* UK P&I Club, No.13, April 1989.

19. *ABB Master Crane Weighing* and other product literature. Asea Brown Boveri.

60. *Code of Uniform Standards & Procedures for the Performance of Draught Surveys of Coal Cargoes.* United Nations Economic & Social Council. Economic Commission for Europe Committee on Energy, Working Party on Coal. 1992.

CHAPTER 14

CARGO DOCUMENTS

Hold inspection certificates, mate's receipts, bills of lading and authorisations to sign them, phytosanitary certificates, certificates of compliance, UN approval, origin, declarations by shipper, certificates of transportable moisture limit, moisture content, master's response sheet, certificates of IMO classification, lashing, readiness to load, fitness to proceed to sea, loading, fumigation, weight and quality, stowage plans, cargo manifests, dangerous cargo manifests, material safety data, hatch sealing certificates, statements of fact, letters of protest, empty hold certificates, trimming certificates and stevedores' time sheets, clean ballast discharge permits and paint compliance certificates

THIS CHAPTER considers the documents which a master may be required to issue or to receive in connection with the carrying of dry bulk cargoes and other cargoes such as steel and forest products which may be carried by bulk carriers.

A master should be aware that there is very often a complex financial background to the physical carriage of the cargo with which he is concerned. There will often be a chain of sellers and buyers with many sale contracts relating to the same cargo. Payments under such contracts will often be made by means of letters of credit whereby banks will make payment against documents presented to them by the party seeking payment. The documents presented will include many with which the master has been directly concerned.

Because the actual documents presented to banks must comply strictly with the description of those documents in the letter of credit, there may be intense pressure on the master to issue documents which comply with the description of the documents in the letter of credit. It is vitally important that the master resists pressure to issue documents when the effect of doing so will be to misrepresent the true situation. He must refuse to issue clean bills of lading, for example, when damaged cargo has been tendered, which should lead to the clausing of mate's receipts and bills of lading to reflect the actual damage condition. Failure to observe this rule may expose the owner to claims such as for shortlanding or cargo damage. A master should always consult his owner in such situations and should be aware of the dangers of signing or issuing documents whose authenticity he doubts or whose contents he cannot verify.

Master to receive maximum information: The master cannot hope to represent the owners and charterers efficiently and reliably unless he is provided with proper information. It is in the best interests of all parties to ensure that the master receives full information about his commercial responsibilities and is provided with clear guidance and clear orders. These should reach him in good time to ensure that he is able to act in their best interests.

Signing of documents: In certain cases a master may wish to acknowledge receipt of a document without binding himself to its authenticity or to the accuracy of its contents-for example, when he is asked to sign a statement of events following a collision. In such cases he may sign the document and add the words 'for receipt only' or 'without prejudice'. Under English law, that would prevent his signature being taken to denote an admission of liability or acceptance of the document as true or correct. He should be very careful to ensure that when placing his signature on a document, even when marking it 'for receipt only' as is prudent, he is not taken under the laws of the country where he is to be accepting the authenticity or the accuracy of the document. If he is in doubt he should consult his owner and/or his owner's P&I Club.

Hold inspection certificate

The hold or hatch inspection certificate, or preloading survey certificate, is issued by a surveyor after inspecting the holds to ensure that they are suitable for the intended cargo.

A preloading survey is required when the local authorities at the loading port or the shipper demand it or when it is a charterparty requirement. Surveys are more likely to be required for sensitive and valuable cargoes such as grain, alumina, fertilisers, pulp and paper, and high-value ores. Such a requirement may be stated in the charterparty. When a survey is required, loading cannot commence in a hold until the surveyor has passed it. Often the vessel cannot present notice of readiness until the hold inspection certificate has been issued, as the vessel may not be 'in all respects ready to load'.

If any holds fail the survey, a vessel on time charter may be placed off hire and a vessel on voyage charter may fail to start time running against charterers until such time as the holds have been resurveyed and passed, although it may be possible to have some holds passed so that the vessel can submit a valid notice of readiness and/or commence to load in suitable holds. The master or his representative (for example, the chief mate) should take careful note of any criticisms offered by the surveyor and should try to obtain a clear idea of the work that must be done to bring unacceptable holds up to standard as quickly as possible.

The thoroughness of the Australian government survey prior to the loading of grain can be seen from the document (Appendix 14.1).

The surveyor will provide the hold inspection certificate for whoever instructs him, but a copy will normally be given to the master. The master has no powers, except the power of reason, to require the surveyor to alter a negative conclusion. If the master considers that the surveyor's conclusions are unreasonable and if the consequences are likely to be costly, the master can set out his views in writing in a letter of protest (see below) or he can obtain the services of another surveyor, perhaps with the help of the ship's P&I club. A second surveyor cannot overrule the first, but can provide evidence of the facts for use in a dispute.

Mate's receipt[84]

A mate's receipt is a printed form, often with handwritten entries, which acknowledges on behalf of the ship the receipt of the goods. It is evidence that the goods specified in it have been delivered to and received by the ship. Usually the person to whom the mate's receipt is given is the person entitled to a bill of lading in exchange for the return of the mate's receipt.

When any damaged or deficient cargo is delivered to the ship it should immediately be brought to the attention of the shippers or their agents so that it can be removed and undamaged cargo supplied in its place. This requirement should be confirmed in writing to provide a record in the event of a dispute.

Alternatively, qualifying words ('clausing') can be inserted to describe the condition of the goods at the time of delivery. As it is a common requirement that bills of lading should be issued in accordance with mates' receipts, if damaged cargo is not removed it will be necessary to clause the mate's receipts which will then lead to the clausing of the bill of lading.

Very careful consideration should be given to the wording of any clausing intended for mate's receipts to ensure that it is accurate. As explained above, the master's primary concern is that no claims should lie against the owner-for example, for cargo damage or shortlanding when damaged or insufficient cargo has been tendered by the shipper. If possible the master may wish to use a form of words which is acceptable to the shippers, but this is not his primary concern or obligation.

When in doubt as to suitable wording for clausing, the master should consult the owners, giving them as much notice of the enquiry as possible. The owners may instruct him to take advice from a surveyor recommended by the P&I club for the purpose.

The sample mate's receipt attached (Appendix 14.2) is taken from the papers of a handy-sized bulk carrier which carried a full cargo of soya bean meal pellets from Sao Francisco do Sul, Brazil, to Iranian ports. The chief officer has endorsed the document 'said to be, said to weigh', 'quantity and quality unknown'. These are common endorsements where the condition and quantity of the cargo is difficult to ascertain or where the ship's figures do not agree with the shore figures. However, this practice will not necessarily protect the owner from claims where there are very large differences which should have been noted.

A mate should not sign a mate's receipt nor a master a bill of lading which he knows is incorrect as the shipowner may be held liable if, for example, the signatory states 'weight and quantity unknown', in a situation where he knows the figures submitted are incorrect. It is better for the master to insist on using the ship's figures or to call for an independent survey to establish the true figure. Provided that he is acting reasonably owners will not be liable for any delay caused. In bulk trades mate's receipts are not always issued, particularly when the master himself signs the original bill of lading.

Authorisation to sign bills of lading

Under a time or voyage charterparty the master in signing bills of lading (Bs/L) acts as agent for the shipowner. Similarly, if a loading broker or charterers' agent signs bills of lading it will be as agent of the shipowner. However, both time and voyage charterparties often contain a demise clause' which will state whether the master or another is signing on behalf of the owner or the charterer.

Under the terms of many time charterparties and some voyage charterparties the owners transfer the authority to sign bills of lading to the charterers, thereby cancelling the authority normally held by the master. In these circumstances the master should not sign bills of lading and cannot delegate authority to others to do so. If in doubt, however, he should request specific instructions first from his owners and secondly from the time charterers. If the time charterers tell the master to do nothing they have retained their own authority to sign bills of lading. If they instruct him to authorise a named agent they have, in so doing, passed their own authority back to the master.

In any case in which the agent will be signing bills of lading on behalf of the master, the master should ensure that the agent receives appropriate instructions in the form of an authorisation which he should issue. The wording of any such authorisation is often dictated by owners' or charterers' voyage instructions and the master should consult his owner if he is in any doubt as to the form of instruction to be issued.

The authorisation should be given to the agent and a copy should be retained by the master, with the agent's signed acknowledgement. A suitable form of words is given in Appendix 14.3 and a copy completed for the soya bean meal pellet voyage is at Appendix 14.4.

It is common practice for agents to present masters with letters of authority which are worded to the agents' own advantage. The master is never obliged to use such forms. He can always use the owners' wording. If the agents refuse to accept such an authority the master should inform owners and time charterers accordingly.

In some trades, such as the grain and agricultural products trades, it is common to have 30 to 40 bills of lading. In these circumstances it is advisable for the master, always acting under instructions, to delegate his authority to one or several named individuals in the agency and to obtain copies of their signatures on all copies of the letter of authority. This will help to reduce opportunity for fraud when bills of lading are presented to the master at the discharge port.

It is important to stress that the master should always be aware of the precise terms of any relevant charterparty clauses and should consult his owners if he is in any doubt as to the existence or extent of his authority to sign bills of lading, whether on behalf of owner or charterer.

Bills of lading

Normally bills of lading (Bs/L) cause no problems, particularly when ships are employed on long-term contracts of affreightment and the parties to the contract are well known to one another. However, the experience of one major operator of bulk carriers in the early 1990s is that bill of lading fraud is widespread in the tramp trades, particularly in some western Pacific countries, and that it is getting worse. In these circumstances safe and rigorous practices are to be strongly recommended. It is good commercial practice for shipmasters to take nothing on trust.

The advice given by different owners varies because such advice is coloured by the particular problems which each has experienced. When there is a problem the consequences can be so serious that the master requires to be guided by his owners and their solicitors. He should not hesitate to consult his owners when in doubt.

A bill of lading (Appendix 14.5) may perform three functions. It is usually very good evidence of the terms of the contract for the receipt, carriage and delivery of the cargo. It is often a negotiable document of title to the goods carried, providing evidence of ownership of the cargo, and it acts as a receipt for cargo loaded aboard the vessel. The master's role in signing bills of lading has been described[64,83] and can be summarised as follows.

Before signing the bill of lading, the master should ensure that:

1. The goods are actually aboard and the bill of lading is correctly dated.
2. The description of the goods complies with the mate's receipts, failing which the bill of lading should be claused accordingly.
3. That he only ever signs the same number of originals as is shown on the face of the bill of lading. If three originals are shown on the document, as is usual, only three should be signed. Particular care is needed when the master has to sign ten or 15 sets of three. (NB. The bill of lading shown [Appendix 14.5] was issued in four originals, which is unusual.)

The master should also ensure that:

4. The bill of lading contains a clause referring to any relevant charterparty, and includes die protection clauses specified in that charterparty. Very specific wording is often required in order to achieve the protection of all relevant charterparty provisions, and the master should consult his owners. However, the master is usually required to sign bills of lading as presented and there is little that he can do except bring the matter to the notice of owners and charterers if the bills of lading do not contain the specific clauses.

The master should not:

1. Sign a bill of lading which is in any respect inaccurate.
2. Be persuaded to sign clean bills of lading against the offer of a letter of indemnity.

Signing the bill of lading: When the master is asked to sign a bill of lading there are six main aspects which he should examine for accuracy. The advice of one shipowner[83], with some amendments, is summarised hereunder. However, it should be emphasised that there are no set rules.

Quantity of cargo: The master cannot be asked to sign for goods which he knows have not been loaded. It is quite common for there to be a small discrepancy between the figure obtained from shore weighing, and the draft survey by ship's officers. The charterparty, or the practices of the trade, will dictate which figure is to be used in the bill of lading. If the shore figure is used, and the ship's figure by draft survey is less, the master will fear that he will be unable to deliver the full quantity stated in the bill of lading. Procedures for dealing with this situation vary from company to company and from one trade to another.

- A discrepancy of up to 0.5 per cent (one owner will reluctantly accept 0.25 per cent) between the bill of lading figure and the ship's figure is considered acceptable in some trades, and it is normal for die master to sign the B/L as presented in those circumstances.
- One owner advises his masters to sign bills of lading as presented when the difference lies between 0.1-0.5 per cent in excess of the ship's figure, but then to inform charterers and shippers in writing.
- If the discrepancy between the ship's figure and the bill of lading figure is greater than 0.5 per cent some owners expect the master to endorse the bill of lading with the remark 'x tonnes in dispute', whilst other owners adopt this wording for any discrepancy.
- Another option is for the master to leave the total blank, insert the remark 'quantity loaded in dispute', and attach a note of protest on a separate sheet of paper, stating what he believes to be the correct figure. When the dispute has been resolved, usually after the vessel has sailed, the note on the bill of lading can be deleted by an authorised agent, the protest removed from the bill and the correct figure entered as appropriate. Once the bill of lading has been corrected and the protest has been removed the bill is acceptable to a bank because it is not considered to be 'dirty', or non-negotiable. If this practice is adopted it is very important that the agent is properly authorised and instructed.
- Other options are open to the master, but may be considered unnecessarily provocative, and should be avoided unless the circumstances are exceptional. For example, he can delete the bill of lading figure and insert the ship's figure, initialling the alteration, or he can tear up the bill of lading and issue his own.
- Endorsements such as 'said to be, said to weigh', 'quantity and quality unknown', or 'weight and quantity unknown' may be isued when the ship's figures do not agree with the shore figures, but this practice will not necessarily protect the owner from claims where there are very large differences which should have been noted. A master may be held liable if, for example, he states 'weight and quantity unknown' in a situation where he knows the figures submitted are incorrect.

Description and condition of the cargo: The master cannot be asked to sign for a description or condition of the cargo which he knows is misleading or of which he has no knowledge. He should ensure that if any part of the cargo is not in good condition, that will be obvious to anyone who reads the bill of lading. If in doubt about clausing the bill of lading he should consult his owners, some of whom will refer him to the local P&I club representative whilst others consider this too important a matter for anyone but themselves.

Date of the bill of lading should be a date on which the vessel completed the loading of the named cargo. If the master is prevented from correcting the date on the bill of lading he should protest in writing to shippers and charterers and leave the bill of lading unsigned, reverting to owners for advice.

Description of the voyage: The master must not sign bills of lading which name a destination which is outside the range named in the charterparty or in the voyage orders or which the vessel cannot physically reach. He must not sign a bill of lading which explicitly forbids transhipment if the vessel's draft will make transhipment unavoidable.

Terms and conditions: As stated above, the background to the carriage of the cargo in question will often be financial, involving a letter of credit. The letter of credit will normally specify clean bills of lading, but will not specify a charterparty, so banks do not normally accept bills of lading containing charterparty terms.

When the master is able to insert charterparty terms in the bill of lading the correct wording is governed by rules of law. When in doubt as to the wording in use, the master should consult his owner.

If the master takes particular care to fill in the relevant clause there should be little doubt as to which charterparty provisions are incorporated. The charterer may have authority to instruct the master to sign the bills of lading as presented, with respect to its terms and conditions. However, subject to the above comments, the master will usually wish to ensure that the blanks are correctly filled when the bill of lading contains words such as This shipment is carried under and pursuant to the terms of the C/P dated . . . between . . . and . . . and all terms clauses exceptions and conditions thereof apply to and govern the rights of the parties concerned in this shipment.'. Some forms of bill of lading contain no such provision, but this does not matter if the document includes the Hague Rules or Hague-Visby Rules as these displace the charterparty provisions.

When there are two or more charterparties covering the vessel's employment the master should consult his owner as to whose terms are to be incorporated in the bill of lading contract.

Payment of freight: A bill of lading which contains no reference to freight having been paid in whole or in part is a receipt only for cargo, but a bill of lading marked 'Freight Paid' or 'Freight Prepaid' may be a receipt for both cargo and freight money.

The master should only sign 'Freight Paid' or 'Freight Prepaid' B/L where he is specifically instructed to do so by owners (but not by charterers), or he is specifically instructed to do so by time charterers if the charterparty allows them to do so, or the charterparty explicitly requires him to do so, or he has good evidence that the freight has indeed been properly paid and received by owners or time charterers, but this should always be checked.

If none of the above conditions is satisfied the master should delete the words 'Freight Paid' or 'Freight Prepaid', and should initial this amendment before signing. If this proves impossible the master should pass the bill of lading to the agent with a written instruction not to issue it without explicit instructions from his owners and should notify owners of what he has done.

It should be noted that voyage charterers cannot insist on a 'Freight Paid' bill of lading being signed before payment of freight unless the charterparty explicitly allows it. In any event the position should be checked. Signature of 'Freight Paid' bills of lading in a situation where freight had not in fact been paid may lead to the loss of the owner's right later to exercise a lien for unpaid freight.

Time charterers can insist on a 'Freight Prepaid' bill of lading being signed provided that the charterparty specifically allows them to do so, but the master should assume that they do not want such a bill of lading signed unless they have given him specific instructions to sign.

Alternative courses of action: If the master finds it impossible to reach agreement with the shippers about the signing of the bill of lading which they present, there are three courses of action which he can follow. All are perfectly legitimate. He can:

1. Delegate the signing of the bill of lading to the ship's agent, instructing him to sign only after receipt of written authority from the owner. The master should immediately cable the owner to inform him of the action he has taken, passing the responsibility to the agent in this manner allows the ship to sail without delay, and buys time for the solution of the dispute. This is a discreet and informal solution to the problem.
2. A second possibility is to follow the procedure described earlier-namely, to endorse the bill of lading with a remark that it is the subject of a dispute, attach a note of protest and authorise the agent to sign when the dispute is resolved.
3. Alternatively he can tear up the shippers' bill of lading and issue his own B/L, using a recognised form. Whilst this response is legal, it may well not be a practical step and should not be done lightly, as it could well result in the vessel and/or master being arrested.

The threat of any of these courses of action may be enough to obtain shippers' consent to modification of the bill of lading which they have prepared.

The master may wish to clause the bills of lading, but he may find that he is threatened with arrest of himself or the ship or heavy financial penalties for delay to the ship if he refuses to sign the bills of lading as presented. In those circumstances, if all other proposals fail, he may in the last resort sign the bills of lading as presented. If forced to do this he should, as soon as he has cleared the port, inform all parties that he signed the bills of lading under duress (i.e., he was forced to sign them) and that he repudiates them. He should then issue new bills of lading.

General considerations at tune of sailing from the loadport: On no account should the master sail without either issuing a bill of lading under his own signature or else delegating the signing to the agent. On sailing from the loadport the master should notify the discharge port agents that he will require to see original bills of lading for the cargo before he will authorise its discharge and he should insist that they acknowledge and confirm his instructions in writing, unless owners have instructed him in writing that they consider this procedure unnecessary.

It is good practice for the master to instruct agents to forward to his owners copies of both sides of a signed non-negotiable bill of lading so that owners can read their contractual obligations and liabilities. If the master should at any time discover that he has issued an incorrect bill of lading, he must notify owners immediately, giving full details of its particulars, including names of shippers and consignees. He must also notify those parties.

Negotiable and non-negotiable copies of bills of lading: Most bills of lading issued in the bulk trades are negotiable, to enable the cargo to be traded while *en route.*

It is normal for three negotiable copies of the bill of lading, stamped 'Original' to be issued. Historically, this allowed the owner of the cargo to despatch copies by different routes to ensure that at least one copy would reach the discharge port in sufficient time to be presented when delivery of the cargo was claimed. Although this is rarely a problem nowadays, the practice still continues. When one negotiable copy of the bill of lading has been presented, the other copies of the same bill of lading are thereby cancelled (null and void). The existence of three copies of the bill of lading does give opportunity for error or fraud and a variety of precautions are recommended to reduce the risk.

In some trades, to ensure that a set of original bills of lading are available in the discharging port, a sealed envelope containing one set of negotiable bills of lading is left in the master's care for delivery to the agents at that port. When this is done it is recommended that all the original bills of lading should be endorsed with the words:

> *One original bill of lading retained on board against which bill delivery of cargo may properly be made on instructions received from shippers/charterers.*[191]

A non-negogitable bill of lading, stamped 'Copy', is evidence of the contract to carry the cargo and of the cargo loaded on the ship, but it is not proof of ownership of the cargo.

Delivery of cargo in return for bill of lading

When the ship has arrived in the discharging port, the cargo must be safely discharged into the care of the correct person before the voyage can be considered successfully concluded.

When the cargo has been received aboard ship and the master has issued a bill of lading in respect of it, he becomes responsible for ensuring that it is delivered to those whom he reasonably believes to be entitled to its possession. The master should only give delivery of cargo against production of one of the three original bills of lading or under specific instructions from owners. It is extremely bad practice to assume that the agent has attended to this matter on the owner's behalf, as this is often not the case.

As noted earlier, the master should give plenty of advance warning to the discharging port agent that he will require to see the original bills of lading. This ensures that the agent has time in which to arrange to comply.

When original bills of lading have not reached the discharge port the owners may agree to discharge the cargo against letters of indemnity provided by the receivers, shippers or charterers, but that is a decision for the owners and not for the master. When the owners instruct the master to accept a letter of indemnity (LOI), they will take steps to ensure that the wording of the LOI presented to the master is the same as that which they have proposed. The master should then check carefully that the LOI presented matches the one supplied to him by owners.

'Accomplished' bills of lading: An 'accomplished' bill of lading is one which has been cancelled, upon delivery of the cargo to its owner. The fact of the delivery accomplishes all the original bills of lading for that cargo. To make the situation clear and to reduce opportunities for fraud, shipowners often instruct masters to write or stamp 'Accomplished' on each side of each bill of lading which is presented to them, to stamp them with the ship's stamp and to sign below this endorsement.

Strictly, the bills of lading are only accomplished when the cargo has been discharged, but if it is acceptable to the receivers it is convenient to endorse them as accomplished when they are first presented. Accomplished bills of lading should be retained by the master for the owners or, failing that, photocopies should be retained.

Proper delivery of cargo against bill of lading

There are three situations in which the master must be particularly alert to ensure the proper delivery of the cargo. These are change of destination, transhipment/lightening, and split bills of lading and/or part cargoes.

Change of destination: If the master receives an instruction to proceed to some port or place other than the one which appears in the bill of lading, he should draw this fact to the attention of all concerned as soon as possible. This rule applies regardless of whether the instruction comes from owners, time charterers, voyage charterers or agents.

There is no P&I cover for misdelivery of cargo, so change of destination is usually the subject of a letter of indemnity (LOI). Provided that the change of destination is confirmed, the master should contact the agent at the new destination to ensure that he has in his possession at least one original bill of lading. Although this document names the original destination, it will still be delivered to the master and accomplished in the normal way, provided that the LOI has been issued and accepted by the owner. The owner will retain the LOI.

Transhipment/lightening: On receiving the instruction to tranship or lighten all or part of his cargo, the master should always ask himself whether this instruction is consistent with the bill of lading. If it is not, he must immediately notify all concerned.

On parting with all or part of his vessel's cargo other than at its final destination, the master should ensure that he receives a clean and plainly worded receipt for it, signed by a qualified person such as the master or chief mate of the other vessel. The master should ensure that the receipt states the full quantity transferred, this being particularly important in the case of part discharge or lightening, as if the vessel has actually discharged more cargo than stated in the receipt there will be a shortage at the next port.

In the event that there is some dispute concerning the quantity transferred at such lightening or transhipment and the master feels that the receipt reads low, he should note this in protest at all subsequent ports of discharge.

Split bill of lading and/or part cargoes: There are two types of split bill of lading. The first occurs where a consignment of cargo described in one bill of lading is split at the discharge port and sold partly to one receiver and partly to another. In these circumstances, delivery is given against delivery orders to which all the conditions of the original bills of lading apply. Usually, the required number of delivery orders is issued by the owner's agent when all the original copies of the bill of lading are presented to him. The master will give delivery of the cargo against production of all the originals plus all the delivery orders. Delivery orders are made out in original only, with no copies, and are often unacceptable to banks, which severely limits their use.

More difficult is the situation in which the charterers require bills of lading for several parcels of cargo when the master originally issued a single set of bills of lading for the entire consignment. For example, it might be that one set of bills of lading was issued for the entire cargo, but the charterers and their traders require three sets of bills of lading, each for one-third of the total cargo. This differs from the first case because three sets of negotiable bills of lading are required. The procedure for dealing with this is simple in theory and difficult in practice. The one set of originals is collected and delivered to the owners or their nominated agents, together with the required number of replacements. The owners destroy the original set and sign and issue the replacement sets. If the master is requested to authorise the issuing of split bills of lading, he should refer the matter to owners and await orders.

The practical point for the master to remember when a cargo has been divided into separate consignments for different ports is that, as with transhipment or lightening, the receiver who receives too much cargo will usually say nothing, whilst the receiver who is short will always claim. Even if the discrepancy can be traced, owners may still find themselves responsible for shortlanding. Every effort should be made to keep an accurate check on the tonnages discharged and to maintain full records of measurements taken, calculations completed and precautions adopted to ensure correct delivery.

Phytosanitary certificate

Most countries of the world have plant health regulations which seek to regulate the import of products such as grain, plants, seeds and fruit. Importing countries require such products to satisfy certain requirements, which vary according to the country and the product.

To meet these requirements, exporting countries must ensure that their exports satisfy the regulations of the importing country. Phytosanitary certificates are issued by inspectors in the exporting country to certify that the requirements of the plant health regulations of the importing country have been met. The inspectors are normally members of the country's plant protection service which, in the UK, is part of the Minsitry of Agriculture, Fisheries and Food.

In some cases the importing country issues an import permit which specifies the information which the phytosanitary certificate must contain. In these cases the import permit is the primary document to which the phytosanitary certiticate is attached. With effect from mid-1993 phytosanitary certificates are not required for trade within the European Community. Instead, a plant passport scheme will operate.

The phytosanitary certificate (Appendix 14.6) was issued by the Primary Protection Department of the Republic of Singapore, in respect of a cargo of rice. The certificate informs readers of the details of the consignment, and certifies that the plants or plant products described have been inspected according to appropriate procedures and are considered to be free from quarantine pests and practically free from other injurious pests, and that they are considered to conform with the current phytosanitary regulations of the importing country. If the cargo had been disinfested or disinfected that information would also be given.

It is normal for the master to receive a copy of the phytosanitary certificate with the other cargo documents. This should be retained and presented to the authorities at the discharge port, if requested.

Certificate of compliance with exemptions to trade sanctions

When trade sanctions have been imposed on a country, it may still be allowed to import certain commodities such as food and medicines. Ships carrying such exempted cargoes will be required to produce a certificate of compliance to the authorities enforcing the sanctions to demonstrate that the cargo qualifies for exemption. Certificates of compliance are issued by the exporting government. The example provided (Appendix 14.7) is a permission to export issued by the Government of Australia. A UN approval certificate is also required.

UN approval certificate

The example attached (Appendix 14.8) takes the form of a letter from a UN official to the government of a country which proposes to export exempted goods to a country which is the subject of UN sanctions. The letter states that the prohibitions in respect of these shipments no longer apply and that the captains of the ships engaged in the trade should be provided with copies of the letter. Particularly, this letter is provided so that it can be produced to the naval ships operating the blockades against countries against whom sanctions are in force.

Certificate of origin

A certificate of origin of a cargo may, for example, be required when the authorities in the destination port are applying an embargo against another country and require to be satisfied that the cargo does not originate there, or where the origin of the cargo must be documented for the purposes of the underlying sale contract.

The certificate of origin, often issued by a government department, states the country of origin of the cargo. It should be issued to the master and will be required by the authorities in the discharging port and possibly in transit ports if they are also applying an embargo. The example (Appendix 14.9) is issued by the Republique de Guinee in respect of a cargo of bauxite.

In some cases the authorities will accept the ship's cargo manifest as evidence of the origin of the cargo, but it is important that the master knows in advance what is required.

Declaration by shipper

The declaration by shipper (Appendix 14.10) is made in compliance with the recommendation of the *BC Code*[22] that before loading the shipper or his appointed agent should provide to the master details, as appropriate, of any bulk cargo in order that any safety precautions which may be necessary can be put into effect. The layout of the declaration and the information it contains will vary with commodity and with shipper, but is becoming increasingly standardised in some trades.

The information which the declaration contains is necessary for the safe planning and supervision of the loading of the cargo and is a Solas requirement from 1 January 1994. The master should, if necessary, demand the declaration in writing and insist on being provided with it before commencement of loading. The information contained in the declaration will help the master to make decisions such as whether it is necessary to trim the cargo reasonably level to the boundaries of the cargo space and whether cargo work should be stopped and the hatches should be closed during periods of rain.

The master or his representative should sign for receipt of the declaration, and should when planning, loading, carrying and discharging the cargo take account of the information provided. The master and the shipper will each retain a copy of the declaration.

Certificate of transportable moisture limits

The transportable moisture limit of a cargo which may liquefy is the maximum safe moisture content of the cargo when carried in a conventional bulk carrier. In practice this figure is normally included in the declaration by shipper.

Certificate of moisture content

The moisture content of a sample of cargo is the quantity of water, ice or other liquid which the sample contains, expressed as a percentage of the total wet mass of that sample[22]. In practice, this figure is normally included in the declaration by shipper. If the moisture content is higher than the transportable moisture limit, the cargo may liquefy and cause the ship to become unstable. In these circumstances the cargo cannot be carried safely.

Complete reliance should not be placed upon the certified value of moisture content. As mistakes in providing the figure can be made and cargo can be wetted by heavy rain whilst stored in the open or during loading, the moisture content of the cargo should be monitored. If there is any reason to fear that it may be close to the transportable moisture limit, the moisture content should be checked using one of the methods described in the *BC Code*[22]. Particular care should be taken when the climate is moist and temperatures are below zero.

Master's response sheet

This document (Appendix 14.11) is issued by some coal shippers to encourage masters to comply with recommendation 3.12 of the coal section of the *BC Code.* This states: 'If the behaviour of the cargo during the voyage differs from that specified in the cargo declaration (i.e. the declaration by shipper), the master should report such differences to the shipper. Such reports will enable the shipper to maintain records on the behaviour of the coal cargoes, so that the information provided to the master can be reviewed in the light of transport experience.'

For the safety of ships and their crews there is a need to know more of how consignments of coal behave during the voyage, and masters should be encouraged to complete and return these forms to report any unexpected experiences with coal cargoes.

Certificate of IMO classification

A certificate of IMO classification must be issued to the master by the shipper before shipment of a cargo which is listed in the *IMDG Code.* This is essential so that he can apply the correct emergency procedures, should they be necessary. Such a certificate is usually in the form of a standardised dangerous goods bill of lading.

On receipt of a certificate of IMO classification, the master should study the emergency procedures, ensure that the ship can carry the cargo safely and confirm that the proposed stowage complies with IMO recommendations. Such precautions as are necessary for the safe carriage of the cargo must be observed throughout the voyage.

Copies of the certificate of IMO classification may be required by the receiver and by the port authority in the port of discharge and also in ports visited *en route*.

Certificate of lashing

The master or his representative may be required to sign a certificate of lashing to state that the stowage of a timber deck cargo or a cargo of steel coils or other cargo which requires lashing has been to his satisfaction.

Before signing he should be satisfied that the deck cargo is securely stowed and lashed. If in doubt as to how the cargo should be stowed and lashed he should consult the *Code of Safe Practice for Ships Carrying Timber Deck Cargoes*[18], or that for *Cargo Stowage and Securing*[96].

After signing the certificate the master retains one copy and the other copies go to the foreman responsible for the lashing.

Certificate of readiness to load

The certificate of readiness to load (Appendix 14.12) is issued by the marine authorities (such as the Canadian Coast Guard, the National Cargo Bureau in the USA, and the Australian Maritime Safety Authority) in respect of cargoes of grain and concentrates and timber deck cargoes, each of which has special loading requirements.

The certificate is issued after satisfactory inspection of the cargo spaces and the pre-loading calculations, and contains reminders of restrictions that must be imposed upon the loading. The restrictions in question are those imposed by international regulations and by the *BC Code*-[2]. The master must ensure that all the restrictions are observed.

Copies of the document go to the master, the port authority, the ship's agent and the port warden. The master cannot present notice of readiness until the certificate of readiness to load has been issued.

Certificate of fitness to proceed to sea

The certificiate of fitness to proceed to sea (Appendix 14.13) follows the certificate of readiness to load, being issued by the marine authorities after satisfactory completion of loading of a cargo of grain or concentrates, or a timber deck cargo.

The certificate records the manner in which the cargo has been stowed and provides reminders of precautions which must be taken during the voyage. It also contains details of the vessel's draft, trim, weights carried and stability on sailing. Copies of the document go to the master, the port authority, the ship's agent and the port warden.

Certificate of loading

A certificate of loading (bulk grain only) (Appendix 14.14) is issued in the USA by the National Cargo Bureau to certify that a cargo of bulk grain has been loaded in accordance with USCG regulations. The document is similar to the Canadian certificate of fitness to proceed to sea. The master signs the certificate to acknowledge receipt. One copy of the certificate is retained by the master, and another by the surveyor.

Certificate of fumigation

A certificate of fumigation is issued by the relevant agricultural or other responsible authority and provides details of the fumigation of cargo, and/or cargo or other spaces.

The specimen certificate (Appendix 14.15) was issued by the agronomist engineer from the Agricultural Authority at Sao Francisco do Sul, Brazil. It records the fumigation of the cargo of '(soya bean meal) pellets in bulk' in the holds of a handy-sized bulk carrier, notes the fumigant and dosage used, and records that fumigation was to continue on passage, the fumigant to be exhausted by ventilation after 72 hours.

A certificate of fumigation is required for two reasons. It will satisfy the local department of agriculture that the cargo is free of infestation and it provides the information which enables an authorised chemist to carry out a gas free test.

A clearance certificate is issued by the chemist when tests show that the residual fumigant has been dispersed from spaces containing cargo or adjacent working spaces and any residual fumigant material has been removed. Such a certificate, when required and issued, is usually provided by a chemist in the discharging port to ensure that cargo, spaces can be safely entered.

The master and the fumigator or chemist each retain a copy of any certificate which is issued and copies may be required by the shipper, the receiver and by the port authorities in the loading and discharging ports.

Certificate of weight and quality

A certificate of weight and quality is issued bv suitably qualified surveyors and samplers and testifies to the quantity of cargo loaded and to its physical description and analytical specification. The example (Appendix 14.16) is issued in respect of a cargo of grain and also records the clean condition of the holds prior to commencement of loading.

In grain trades this is the document from which the mate's receipt and bill of lading are drawn. It is therefore of vital importance to all concerned with the cargo. In some cases the certificate of weight and quality may be treated like a mate's receipt. If asked to countersign such a document the master may sign 'for receipt only' if he cannot verify the accuracy of all the information which it contains.

Stowage plan

The stowage plan, otherwise known as the cargo plan or the hold distribution plan, shows the commodity, tonnage and/or measurement of cargo in each hold. The plan may be produced by one of the ship's officers (Appendix 14.17) to provide a record of the loading as observed and measured by ship's personnel, in which case it may also provide information about the bunkers carried and the vessel's draft, trim and stability. Where there is a discrepancy between the cargo tonnages as calculated by different people using different methods, the ship's plan is likely to show the bill of lading tonnages, though the ship's figure may also be stated.

Alternatively, the stowage plan may be produced by someone from the loading installation (Appendix 14.18) to record the quantities loaded in each position. A stowage plan provided by shore-based staff will normally show the shore values for the tonnages loaded, regardless of whether or not these are the figures used in the bill of lading.

The simplest plans are produced for the simplest cargoes. When the cargo is provided by a single shipper and consists of a single commodity for a single consignee, the stowage plan need show little more than the tonnage loaded in each hold. The stowage plan must be more complex when the cargo consists of several commodities for several consignees in a number of ports, as may happen when the cargo consists of a number of parcels of forest products, steel, ores or different grades of coal. The plan must show the different commodities, and the tonnages and B/L numbers of each parcel.

When the cargo consists of several different parcels in a single hold, it is essential that the cargo for the second discharge port does not overstow the cargo for the first discharge port and the stowage plan must show clearly which parcels of cargo overstow which others. This is necessary so that the sequence of discharge of the cargo can be planned and amended if necessary. The accepted practice is that the parcel shown (on the plan) nearest to the top of the hold is the first parcel to be discharged and the parcel shown lowest is the last to be discharged. When two parcels are shown side by side, either can be discharged first.

For example, in the plan at Appendix 14.17, No. 2 hold is shown as containing cargo for Cleveland, Toledo, Detroit, and Chicago. The cargo for Chicago is shown standing on its own ground, and with nothing overstowing it. Consequently, it can be discharged either before, or after, the cargo in the after end of the hold. In the after end the Detroit cargo is overstowed by the Toledo and the Cleveland cargo, and the discharging sequence must be Cleveland, then Toledo, then Detroit.

When several parcels of similar cargo-it could be timber, woodpulp or steel products-are stowed in the same hold they must be separated by a distinctive separation material. Materials used for cargo separations include polythene netting, plastic sheeting, coloured ropes, plywood, wire netting and separation quality burlap. The separations should be carefully and accurately shown on the stowage plans. The cargo of logs carried by a handy-sized bulker (Appendix 14.19) from the USA to three Japanese ports was separated, port by port, with coloured ropes, and the separations are shown on the plan.

When stowage plans are drawn by the loading stevedores, they are intended as a record and to provide information for the ship's staff and for the discharging stevedores. Similarly, stowage plans prepared aboard ship are for the ship's records and for the discharging stevedores, and possibly also for the loading stevedores. Copies of stowage plans may also be sent routinely to the owners and/or charterers of the vessel.

Cargo manifest

A cargo manifest (Appendix 14.20) is issued by the shippers or their agents in the loading port and is based upon the information contained in the Bs/L. It provides brief details of the ship and the loading and discharge ports and lists details of the cargo carried. Details include the B/L number, shipper, consignee, marks and numbers, contents, gross weight and freight.

Copies of the cargo manifest, if available, are retained by the master, who will give copies to the authorities in the discharge port and ports visited *en route,* if required. In some trades the manifest may not be completed and available to the master before the ship sails, but if required to produce one he can complete his own from the information in the Bs/L.

Whilst the master may not be required to sign the manifest produced by the charterer he should satisfy himself as far as possible that it is an accurate statement of the cargo carried.

Dangerous cargo manifest

A dangerous cargo manifest (Appendix 14.21) is issued by the shippers or their agents in compliance with the regulations which apply at the loading port. The document states the quantity of hazardous material carried and certifies that it is properly named, prepared and otherwise in proper condition for bulk shipment.

The name and description of the hazardous material as given in the dangerous cargo manifest can and should be used to confirm the stowage requirements for the cargo, as stated in the *BC Code*[22] and/or the *IMDG Code*[8].

The document will be presented to the master for his signature, and before signing he should satisfy himself, as far as is reasonably possible, that the stated quantities and positions of the cargo are correct, and that the cargo has been stowed in accordance with the requirements of the codes.

Correct stowage is necessary to ensure safe carriage of the cargo. Failure to carry the cargo in the manner specified in the codes could expose the ship and those aboard her to hazard and could weaken a claim for compensation in the event of loss. Indeed, it could lead to a claim against the ship if the cargo is lost or damaged through incorrect stowage.

The master and shipper will each retain one copy and a further copy or copies may be required by the authorities in the loading and discharging ports.

Material safety data

Material safety data sheets (Appendix 14.22) provide detailed information about hazardous cargoes. They are issued in the USA. The data include useful information about the health hazards and other dangers associated with the commodity, protective equipment to use, additional precautions, and emergency and first aid. When local regulations require that such information must be available for shore workers, it is reasonable to obtain it for ships' personnel, too.

Hatch sealing certificate

Cargo hatches may be sealed to prevent theft of cargo or because the holds have been fumigated and are unsafe to enter. When hatches have been sealed by a shorebased organisation a certificate recording the fact is usually issued. The example (Appendix 14.23) lists the compartments which have been sealed and the type and serial number of the seal used. When countersigning, the master or chief officer will ensure that the information entered in the certificate is correct.

Statement of facts

A statement of facts (SOF), sometimes known as a port log, is prepared by the ship's agents in each loading and each discharging port. It is intended to provide a full record of the times of those events which may be required for the preparation of the laytime statement and which may affect claims for dispatch and demurrage or for offhire.

The example (Appendix 14.24) is for a handy-sized bulker loading soya bean meal pellets in Sao Francisco do Sul, and provides a good example of the information which should be included in such a document.

The SOF should detail the vessel's arrival at the pilot station, the anchorage and the berth, and should note the time of pilot boarding and the arrival of tugs. Tendering and receipt of notice of readiness and granting of free pratique should be recorded, as should the clearing (i.e. passing) of the holds by the pre-loading surveyor.

Periods of loading or discharging should be recorded, as should the times of stoppages, with their reasons. Weather which interrupts cargo work and adverse weather at any other time should be noted.

Cargo tonnages, bunker figures and drafts should be recorded. The time of sailing should finally be entered with other significant times, such as time of completion of fumigation, and any unexpected delays with their reasons.

The master should check the accuracy of the SOF before he signs it. He should insist on correction of the statement of facts when it is inaccurate, or should add remarks stating the correct facts if the agent refuses to amend the document to his satisfaction. The SOF is signed by the master and sometimes by representatives of both owners' and charterers' agents. It may also be signed by a representative of the shipper. Copies are retained by each party.

In some trades, particularly to the USA, the presentation to the master of incomplete SOFs is said to be an increasing problem. The first page, with arrival data, is presented and the master is asked to sign a final page, permitting later insertion of more data on a middle page. The reason given may be that the times from the loading facility are not yet available. The master should never sign such a blank cheque.

When presented with such a proposal the master should insist that the SOF is as complete as possible, and should then draw a line beneath the data entered and attach his signature. He should then formally delegate to the agent the responsibility for ensuring that the remainder of the SOF is completed correctly.

Letter *of protest*

A letter of protest is a document used to provide a written record of a dispute. The master should write a letter of protest whenever he considers that shippers, stevedores or any other parties are responsible for an event or circumstance which will cause a loss to the ship. For example, the master should write a letter of protest to the shippers if they fail to provide a full cargo in accordance with the voyage charterparty. He should write a letter of protest to the stevedores if the ship is unable to work cargo because they have failed to inform him of special requirements and cargo work is delayed while the cargo gear is adjusted, for example.

The master is liable to receive a letter of protest if the vessel fails in some way to perform in accordance with the charterparty. For example, a letter of protest is likely to be issued if the vessel is unable to accept the quantity of cargo stipulated in the charterparty or if loading or discharge of cargo is interrupted because of a fault of the ship.

When writing a letter of protest, it should be remembered that its meaning must be clear to whoever may be asked to resolve the dispute as well as to the person to whom the letter is addressed. The facts of the matter should be stated plainly and in sufficient detail to make clear why the protest is being made. The letter should include a clear statement of why the addressee is considered responsible for the problem reported and of the action he must take to remove or minimise the problem. An example of such a letter is at Appendix 14.25.

Empty hold certificate

When there is any doubt as to the outturn of the cargo-for example, if the receiver is claiming that his cargo has been short-landed-the master can issue an empty hold certificate. Such a certificate will say that all cargo has been discharged and that the holds have been emptied. The stevedore supervisor will be asked to sign the certificate (Appendix 14.26) to confirm that no cargo remains aboard.

The master will keep the original of this document and can give copies to the stevedore who signs it and to the ship's agent. Some owners instruct masters to obtain empty hold certificates for every cargo carried and this is a safe commercial practice to adopt.

Trimming certificate

The trimming certificate (Appendix 14.27) is a document which the master or his representative may be asked to sign to confirm that he is satisfied with the manner in which the cargo has been trimmed.

One serving shipmaster advises his colleagues to add a clause saying 'The cargo has not been trimmed in compliance with the *BC Code,* as the cargo has not been trimmed reasonably level to the boundaries of the cargo space' when this is the case. He reports that the stevedores presenting the document usually withdraw it rather than accept the endorsement. The master will give the original of this document to the stevedores' representative or to the agent and will retain a copy.

The certificate of fitness to proceed to sea issued by the port warden, coastguard or similar authority also testifies to the trimming of the cargo, but the trimming certificate is issued by the master, not the authorities.

Stevedores' time sheet

The stevedores' time sheet normally shows the number of gangs employed, the hatches worked and the equipment used, with dates and hours worked and times and reasons for stoppages. If asked to countersign this document the master should, of course, ensure that it is correct. He should insist on correction of the stevedores' time sheet when it is inaccurate, or should add remarks stating the correct facts if the agent or stevedore refuses to amend the document to his satisfaction. Alternatively, he can sign 'for receipt only'.

Clean ballast discharge permit

A clean ballast discharge permit is a document which is becoming more widely used in many parts of the world. The example (Appendix 14.28) authorises the vessel to discharge clean ballast in the Port of Long Beach and stipulates the conditions which must be observed whilst ballast is being discharged.

The permit is issued by the port authority following application from the ship's agent and a copy has to be posted at the ship's gangway, with a record of 'checks and condition of discharge'. In Vancouver, a certificate is issued by the port warden at the time when the vessel is first boarded, after the first discharge of ballast has been sighted and found acceptable. A similar permit is required in some parts of the world for the discharge of bilge water.

Paint compliance certificate

If holds have been repainted shortly before a cargo of grain or other foodstuffs is to be loaded the shippers may demand to see a compliance certificate for the paint used. Such a certificate, (Appendix 14.29) issued by an independent laboratory, states that all the materials used to make the paint are approved for use on surfaces which are in contact with foods. The details of the relevant regulations appear on the certificate.

Stevedore damage form

These documents are issued by the master or his representative, to hold the stevedore responsible for damage to ship or cargo. (They are described in Chapter 3.)

Notice of readiness

The procedures associated with the tendering of notice of readiness are described in Chapter 2. A sample notice of readiness is attached (Appendix 14.30).

Sources

18. *Code of Safe Practice for Ships Carrying Timber Deck Cargoes.* International Maritime Organization. 1981.

22. *Code of Safe Practice for Solid Bulk Cargoes.* International maritime Organization. 1991.

64. Llewellyn, TJ. *The Master's Role in Signing Bills of Lading.* Nautical Institute North East Branch. 1990.

82. *International Maritime Dangerous Goods Code.* International Maritime Organization. Consolidated Edition; 1990.

83. *Notes for the Guidance of Masters: Signing Bills of Lading for Bulk Cargoes.* Bibby Line, Liverpool. 1978.

84. Rayfield R. *Nature & Function of the Bill of Lading & Mate's Receipts.* Nautical Institute North East Branch. 1990.

96. *Code of Safe Practice for Cargo Stowage and Securing.* International Maritime Organization. 1992.

191. *Bills of Lading: Delivery of Cargo Against one Original Bill of Lading Carried on Board.* The London Steam-Ship Owners' Mutual Insurance Association Ltd. Circular. July, 1990.

CHAPTER 15

LOADED VOYAGE

Departure from the loading port, choice of route, cargo ventilation, soundings, acidity of bilges, cargo temperatures, sampling of air in holds, checking and tightening of cargo lashings daily, inspections in fair and rough weather, conduct of the voyage in rough weather, reporting, arriving at the discharging port

Departure from the loading port

IN Chapter 12 it was noted that it is normal for all the hatches to be secured for sea and their securing checked by the chief mate before the vessel leaves the berth. An exception may be made when a vessel has a long passage to complete from the loading berth through sheltered waters before the open sea is reached. In these circumstances, if the paperwork can be completed promptly, time can be gained by completing the securing of the hatches after the vessel has left the berth. For Cape-sized vessels the ports of Kanogawa, Ponta Da Madeira and Dampier come into this category, and the grain loading port of New Orleans and the iron ore port of Narvik are two examples of ports where this approach is justifiable for Panamax-sized vessels. Many more examples could be quoted for handy-sized and mini-bulkers. If there is a high tide to catch or if daylight is required for the transit, there is an added reason for departing as quickly as possible and completing the work of securing whilst proceeding towards the sea.

Once the berth has been cleared and tugs have been released, mooring lines must be secured on their reels and covered or passed below decks into the rope stores. Anchors must be secured when deep water is reached and there is no realistic possibility of using them.

Cargo residues lying on deck should not be washed or swept overboard whilst the vessel is in the port approaches or coastal waters. Light residues such as grain are liable to blow over the ship: they should be swept into piles between the hatches and damped down for disposal once international waters are reached. Heavy residues like iron ore can be left on deck to be swept or washed overboard in international waters. (The regulations for the disposal of cargo residues are described in Chapter 25.)

Essential cleaning should be done. For example, a clear path along the deck to the pilot ladder must be swept or washed, and if the pilot is to be discharged by helicopter the helicopter landing hatch cover and the two covers next to it must be washed down. This is to prevent dust being drawn into the helicopter engine, where it might cause failure, and to avoid the creation of a dust fog.

Choice of route for the loaded voyage

The obvious first choice of route for the loaded voyage will be the most direct one and often this will be the best, but there are various reasons for considering alternatives. When choosing the route, the master should take into consideration the ship's loading and operational requirements, plus climatic and weather data.

Loading and operational requirements: A ship which has been soundly built and properly maintained ought to be able to face normal heavy weather without suffering structural damage, but there is no benefit to be gained from meeting adverse weather on the direct route if more favourable conditions can be found on an alternative route. Furthermore, no master should let his vessel remain in the path of exceptional weather, such as is met near a tropical cyclone, when there is an alternative.

The ship's loading and operational requirements are dictated by such facts as the cargo the vessel is carrying and, where applicable, the way it is secured. The master of a ship carrying a deck cargo of steel pipes, timber or woodpulp, or with holds loaded with steel coils lashed with strapping bands, for example, will want to avoid heavy adverse swell as far as possible. Heavy seas shipped on deck can dislodge deck cargo, and the ship's violent motion can cause steel coils to break adrift in the holds. If the cargo requires ventilation the master should try to avoid weather which makes it impossible to ventilate.

A strong case can also be made for choosing a route to avoid troubles. Coasts where civil strife has led to the shelling of passing ships, areas where pirates are known to operate and areas where large concentrations of fishing vessels can be expected are all well worth avoiding.

Climatic data: Climatic data include the observations of currents and wind and wave height and direction taken over a period of years. In low latitudes within the tropics, the weather and wave conditions remain stable for long periods except when tropical cyclones occur, and these data published by hydrographic authorities are very reliable. In low latitudes a choice of route which takes account of prevailing currents, winds and swell conditions is likely to be successful. It is reasonable for a master to set courses which increase the distance over the ground, provided that the extra distance is outweighed by benefits such as a favourable current, or a better speed through the water.

If the arithmetic shows that on indirect route 'B' making good 14 knots, the vessel will arrive in port earlier than by direct route 'A' where only 13 knots can be expected, then the decision to use indirect route 'B' is justified.

It is climatic data which influence a shipmaster when he chooses an indirect route across the Arabian Sea during the SW monsoon or remains further from the South African coast when rounding the Cape from west to east to avoid the adverse effect of the Agulhas current.

The routes recommended in *Ocean Passages of the World*[30] are based on climatic data, and such data can be found in routeing charts, current atlases, tidal stream publications and sailing directions.

Weather forecasts: In higher latitudes the weather is less stable than in the tropics, being regularly disturbed by the depressions which cross the oceans. In these areas the use of weather forecasts is essential when choosing the best route to follow: swell and wind conditions can be very different over a distance of no more than a few hundred miles.

A departure from the direct route (i.e., from the great circle route) in higher latitudes is most likely to result in a saving when the route runs easterly or westerly because that is the direction in which the weather systems travel. It is mainly in east-west crossings of the North Atlantic, North Pacific and the three southern oceans that savings in time and/or fuel can be made by good route choice.

Experienced masters can learn to recognise the weather patterns over the oceans and to choose their route accordingly. During periods when conditions are favourable the planning of the route is easy, but ocean voyages may take 10-30 days and there can be few shipmasters who have the resources to plan optimum routes so far ahead through adverse conditions.

For the mariner the forecasting of swell height and direction is even more difficult than the predicting of wind, yet swell is the factor which has the greatest effect on ships' speed and movement. No long-term swell forecasts are broadcast. The difficulties for a shipmaster of forecasting, days in advance, the nature and effects of adverse weather on his ship and the desire for voyages completed economically and without losing time or damaging cargo, have led to the development over the last 25 years of ship routeing services. Improved communications and data processing have made such services possible.

Ship routeing services: Ship routeing services serving the whole world or more limited areas are provided by several commercial organisations which have the resources to predict the weather and to forecast a ship's progress along alternative routes so that the most suitable one can be chosen. The size of their data bases and the power of their computers enables them to assess the options and choose the best route in a way that no mariner could hope to match consistently.

As an example, the Metroute organisation, part of the UK Meteorological Office with its considerable resources, can be quoted. It receives regular and frequent weather reports from numerous sources situated all round the world, including data from satellites, and uses operational computer models which produced (1993) detailed forecasts of winds and waves for five days ahead.

Metroute, like its competitors, asks the purpose of the routeing-to minimise fuel consumption, or to minimise adverse weather, for example-and recommends an appropriate route. The route is chosen by professional mariners working for Metroute on the basis of the forecast weather and the ship's anticipated performance. The ship's performance is forecast on the basis of her particulars and the experience which the forecasters have in their computerised records of routeing similar ships. The ship reports her position at intervals during the voyage so that her progress can be monitored and the route amended when changing conditions required it. Metroute also monitors sea ice and the recommended routes take vessels clear of ice infested waters.

After the voyage the routeing organisation provides a comparison between actual and possible alternative routes to demonstrate the benefits of the routeing advice. The routeing organisation can also provide comparisons between actual speeds achieved and charter speeds, after taking account of the weather and currents experienced. These comparisons can be provided regardless of whether or not the vessel was routed on the voyage in question. A fuel consumption monitoring service is provided as an optional extra and is used by many charterers.

When to use a ship routeing service: It is common for charterers to insist on the provision of a ship routeing service for the loaded voyage, particularly for east west crossings of the oceans outside the tropics. However, although charterers instruct the master to be guided by the routeing service they usually also stipulate that the route taken is to have due regard to the safety of ship and cargo, thus requiring the master to continue to use his own judgement to ensure that the voyage is safely accomplished. The use of the ship routeing service enables the charterers to be satisfied at modest cost that the chartered ship has followed the optimum route.

When routeing is not a requirement of the charterers it is still open to the master to request owners or charterers for permission to use a routeing service and some owners and charterers will expect him to do so when benefits can be expected.

Individual cases must be judged on their merits, but routeing services for bulk carriers are likely to provide the biggest savings in fuel consumption, and/or the greatest reduction in damage, when one or more of the following conditions are met: voyage is outside the tropics: voyage is through the tropics during tropical cyclone season: voyage runs more east to west than north to south: the shortest route would take the vessel into very high latitudes: voyage is during bad weather period (e.g., winter or monsoons); ship is medium- or low-powered; ship is in ballast or has a deck cargo; master has little experience of the region; ship's facilities for receiving weather data are poor.

Cargo ventilation

Speaking generally, bulk cargoes are ventilated to prevent the formation of cargo sweat or ship's sweat which could damage the cargo, to reduce the harmful heating of a cargo, and/or to remove hazardous gases from the cargo spaces. Ventilation in the wrong circumstances can do considerable harm and before a decision is made to ventilate a space it is necessary to consider the requirements of the cargo, the temperature and humidity within the holds and outside and the presence or absence of sea spray. The types and positions of ventilators with which the ship is provided must also be taken into account.

Hold ventilators: It is usual for any bulk carrier to be provided with two or four ventilation trunks per hold, with one or two situated at the fore end of the hold, and one or two at the after end. To avoid passing through the topside tanks the ventilator trunks are situated close to the ship's centreline. Within the hold each such trunk often terminates in a simple square, round or rectangular opening in the deckhead (Fig. 15.1). Alternatively trunking may continue down the bulkhead, with slots at intervals to admit air to the hold

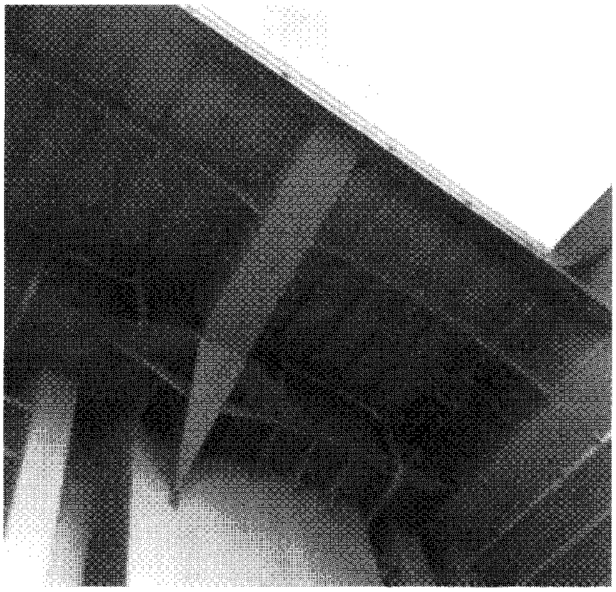


FIG 15.1 VENTILATOR OPENING IN DECKHEAD

at various levels. Portable plates can be put in place to close the lower slots, when ventilation at lower levels in the cargo is not wanted.

Above deck the ventilation trunks may stand alone, each fitted with a mushroom cowl which gives some protection from spray and from the direct, force of any wind (Fig. 6.2), or they may be built into the structures of the masthouses with openings situated in the masthouse sides, the maslhouse top (Fig. 6.1), or- al the masthead (Fig. 6.3).

Every ventilator must be provided with a means of closing so that all ventilation can be stopped in the event of fire. The means of closing may be in the form of a ventilator flap set within the vent trunk (Fig. 6.3) and operated by an external lever, or a watertight door (Fig. 6.1), or may consist of a cowl which can be screwed down into a closed position by the operation of a valve wheel (Fig. 6.2).

Some bulk carriers are provided with ventilator fans set in the trunks of ventilators. When fans arc-provided they are normally fitted in the ventilator or ventilators at one end of the hold. Ventilator fans can usually be run in both directions so that they can be used either to deliver air to the hold or to draw air from the hold. It may be possible to vary the speed of the fans, selecting full speed or half speed or a larger range of options. Ventilation assisted by fans is known as mechanical or forced draught, ventilation, whilst ventilation which occurs as a result of natural movement of air is called natural ventilation. Natural ventilation can occur as a result of a wind blowing, the ship's motion, or the circulation of air resulting from temperature differences.

The *Reginn Oldendorff* is provided with one ventilator at each end of each hold. These ventilators pass vertically through the masthouses with the forward ventilator in each hold being on the starboard side and the after ventilator on the port side. The ventilators terminate on top of the masthouses with grilles which face aft and are provided with watertight doors (Fig. 6.1). No fans are provided, so the ventilation is natural.

In addition to the main hold ventilator's already described, some btrlk carriers are provided with ventilators of the hinged-door type set into the hatch coamings, whilst portable ventilator cowls are also provided for some bulkers to be bolted in position on the hatch covers when blank plates have been removed. Such additional ventilators are necessary to provide surface ventilation within the hatch square when a ship is carrying a cargo which fills the hold to coaming level, thereby sealing off the hatch square from the rest of the compartment (Fig. 15.2).

Reasons for ventilating bulk cargoes: A number of difficult cargoes have special ventilation requirements to prevent overheating or to remove darigerotrs gases. In such cases masters and officers should be guided by an instructions provided by owners, charterers, shippers and/or the *BC Guide'''*.

In Chapter 19 the carriage of several typical cargoes is described and these provide a good illustration of the varied reasons for ventilating. Coal is ventilated to remove heat and hazardous gases. With grain and steel a major object is to avoid the formation of sweat, which would damage the cargo. In addition there can be a need to remove heat from grain cargoes. Iron ore has no particular need for ventilation although it is desirable for access and to reduce corrosion to maintain a dry and healthy atmosphere in the holds.

When there is no special need to remove gases or heat, the reason for ventilating is to remove moist air and replace it with drier air to discourage the formation of sweat.

Sweat: Sweat is the name given by seamen to condensation which occurs in a ship's cargo spaces. There are two types of sweat, ship's sweat and cargo sweat. For sweat to occur there must be moisture in the hold atmosphere and a difference of temperature between the air in the hold and the cargo or- the ship's steelwork.

The temperature difference usually occurs as the ship moves from one climatic region to another or from a cold to a warm current or vice versa, arid the larger the change irr temperature the more likely is the formation of sweat.

Sources of moisture in cargo spaces: The most important source of moisture in a hold is the cargo. Most commodities, particularly materials of vegetable origin, posses some natural moisture and create an atmosphere, known as the storage atmosphere, in any compartment irr which they are stored[3]". Moisture in a hold can also be the result of rainfall during loading and the air in a hold will be moist if conditions were moist when the hold was closed orr completion of loading.

The amount of moisture in the air is measured by its dewpoirrt, which is the lowest temperature to which a mass of air can be reduced without condensation occurring. As condensation is a 'bad thing' it is helpful to remember- that air with a high dewpoint is a 'bad thing'. Dewpoirrt is obtained from a table, entered with readings taken from the wet and dry bulb hygrometer.

Cargo sweat: Cargo sweat consists of condensation which forms on the surface of cold cargo when warm moist air comes in contact with it (Fig. 15.3). Cargo sweat will form when the dewpoint of the air in the hold is higher than the temperature of the cargo. This is most likely to occur when the ship has loaded a cargo

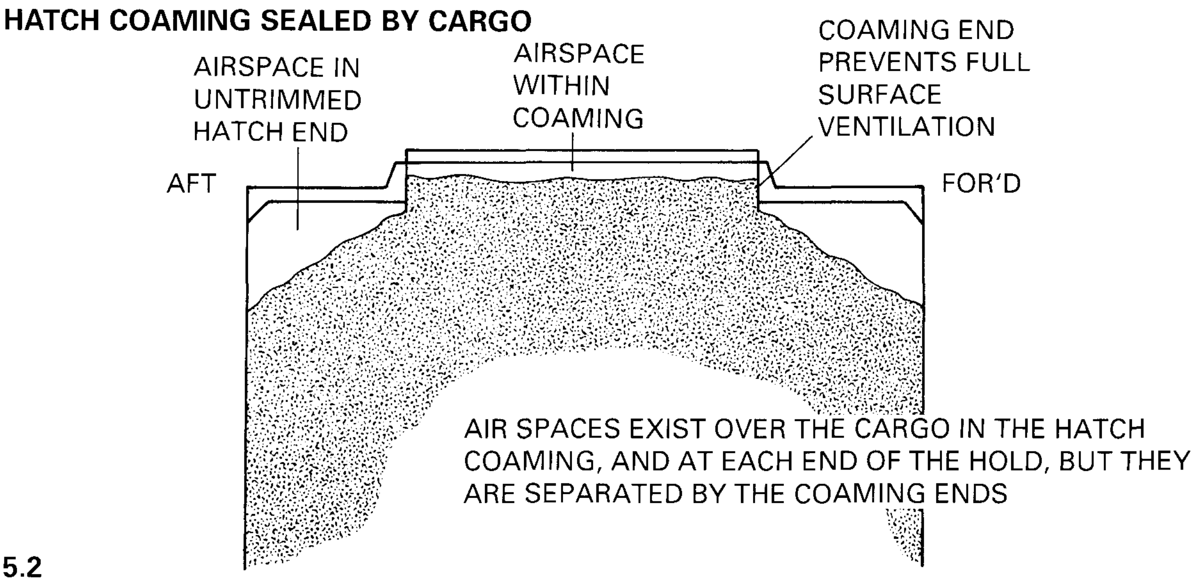


FIG 15.2

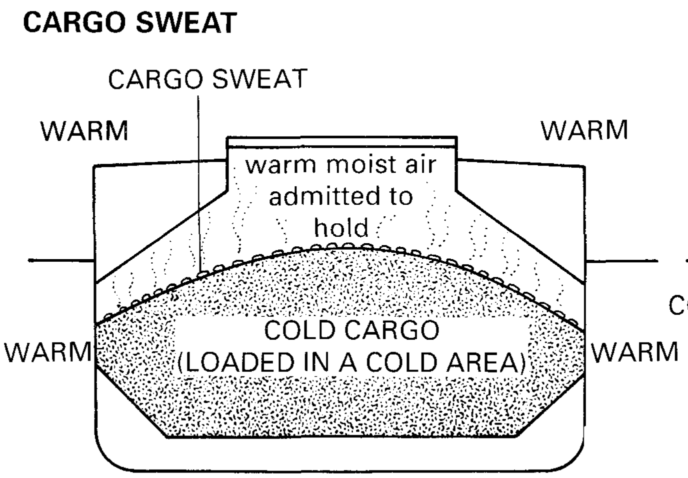


FIG 15.3

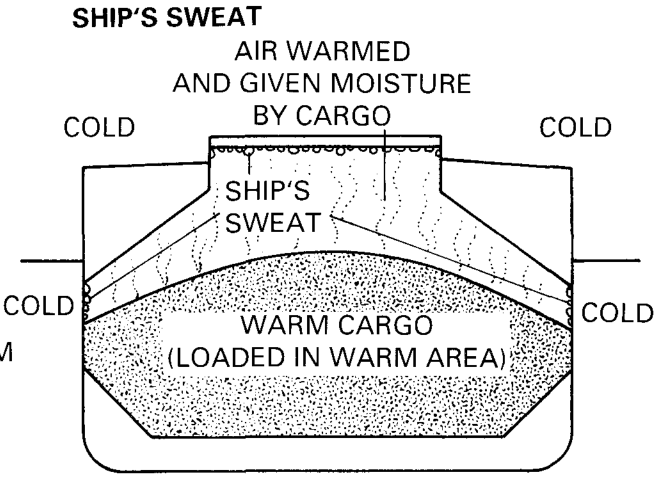


FIG 15.4

in a cold region and air is admitted to the hold as the ship is travelling towards a warmer region.

To prevent cargo sweat when passing from a cold region to a warm region all ventilation should he stopped and the hold should be kept closed, with the air unchanged, as far as possible. The temperature of the cargo will only rise very slowly to equal the external atmosphere, and so long as the hold remains closed the air within it will gradually become warmer and able to hold more moisture.

With an inert cargo the dewpoint of the air in the non-ventilated hold remains constant as it warms up. If the cargo contains moisture it will give off moisture as it warms up. However, as the heat will flow from the shell of the ship into the hold atmosphere and from the hold atmosphere to the cargo, the temperature of the hold air stays a step ahead of the cargo temperature. Any moisture given off by the cargo can be held in the air.

It will be safe and desirable to ventilate only after the surface temperature of the cargo has risen to equal that of the air outside the hold or when the external air is exceptionally dry, so that its dewpoint is lower than the temperature of the cargo.

Ship's sweat: Ship's sweat is the condensation which occurs when warm moist air in the hold comes into contact with the cold steelwork which forms the deck and shell plating of the ship (Fig. 15.4). Ship's sweat will form when the dew point of the air in the hold is higher than the temperature of the ship's steelwork, conditions most likely to be met when the ship has loaded in a warm region and is steaming towards colder climates. Ship's sweat caused by a low external air temperature is most likely to be deposited first in the vicinity of the hatch coaming and the fore and after ends of the hold amidships, as the topside tanks, even when empty, pro\ide an insulating layer which delays the penetration of cold from the external air to the plating forming (he tank/hold separation.

When a cold current is met, causing a low sea temperature, the side shell plating between the topside and lower hopper tanks will be cooled, providing conditions favourable for the formation of ship's sweat in those areas.

When passing from a warm region to a cold region full ventilation should be continued whenever possible in order to withdraw moist air from the hold and replace it by drier external air. If the cargo contains moisture, the air in the hold will continue to be moist and will condense upon the ship's cold steelwork unless it is continually extracted, and replaced by drier air.

General guidelines for ventilation: Ventilation should be stopped, by stopping fans and closing the ventilators, when the vessel is shipping spray in the vicinity of ventilator intakes. Times of interruption of ventilation should be logged.

Cargo holds should be ventilated when the dewpoint of the external air is lower than the dewpoint of the air in the hold. This will put drier air into the hold, forcing out wetter air and reducing the possibility of sweat forming. Dewpoint readings should be logged.

On short voyages in small ships such as mini-bulkers employed in the European middle trades it is normal to carry out no ventilation and to keep ventilators tightly sealed. With a low freeboard and regular rough weather the danger of shipping spray into open ventilators is usually found to be far greater than the potential benefits from ventilation.

Ventilation practice: When natural ventilation is being used with open ventilators at both forward and after ends, the air in the hold tends to travel from aft to forward. When forced ventilation is used it is normal to take advantage of this tendency and to drive the air from aft to forward.

Air forced into a hold by a fan will seek the shortest and easiest route through the hold. If the only route by which the air can leave the hold is through a ventilator at the far end of the hold, the air will tend to flow directly to that ventilator across the surface of the cargo. If an access hatch or other opening close to the inlet vent is left open, the air will leave the hold by the access hatch without travelling the length of the hold. This is known as 'short cycling' and is an inefficient form of ventilation. Short cycling should be prevented by ensuring that only ventilators are left open when the hold is closed.

When a hold is loaded with a bulk cargo the ventilation provided is usually surface ventilation, with air flowing over the surface of the cargo from ventilators at the after end of the hold to ventilators at the fore end of the hold.

Ventilators situated at the hold ends can provide surface ventilation only for the nearby hold ends when the cargo is a low-density one topped up in the hatch square and preventing a flow of air from one end of the hold to the other. When the hold is filled the hatch square requires separate ventilation. (Fig. 15.2)

Through ventilation of a bulk cargo, when air is forced into the body of the cargo, is not normally required and is difficult to achieve. Some through ventilation can be provided aboard ships in which ventilator trunks extend to the bottom of the hold bulkheads. Through ventilation of coal is likely to cause heating and must be avoided.

The capacity of a ship's hold ventilation fans is normally expressed in the number of air changes that can be achieved in an empty hold per hour. When a cargo is carried the number of air changes per hour will be increased, because the quantity of air which the hold contains is reduced.

Soundings

Importance of soundings: Throughout the loaded voyage, as at all other times, soundings of cargo spaces, ballast tanks, void spaces and bunker tanks should be taken and recorded daily by the same competent person. The readings obtained should be inspected carefully for any unexplained increases or decreases in the values observed. When the sounding positions are located on the open main deck and when the vessel is in adverse weather with a low freeboard, it is often unsafe to obtain soundings on the ship's weather side or even on both sides. This is unfortunate, though unavoidable once the ship's design has been finalised. In these circumstances the chief mate should be alert for any opportunity occurring when in the lee of land or because of an improvement in the weather to obtain a set of soundings. Reasons for any failure to obtain soundings should be logged.

In recent years there have been numerous indications that aboard badly-run bulk carriers a full set of soundings is sometimes not obtained for days or weeks on end. It is true that in almost every case the soundings when taken only confirm what the chief mate already knows-namely, that the ship is not leaking. But it is only when soundings are obtained daily, at the very least, that there is a reasonable chance that any damage or oversight will be detected promptly when it occurs. The lives of seamen and the safe delivery of cargoes can depend upon this seamanlike precaution and it should never be neglected. A Panamax bulker which suffers damage to her forepeak can find herself with 1,000 tonnes of water in that compartment on a loaded voyage. The consequences would be a trim seriously by the head and longitudinal stresses of 150 per cent of the permitted values!

High soundings in 'empty' tanks: Warning of a leak is provided by increased soundings in ballast tanks or void spaces and must be investigated promptly. First it may be necessary to pump out the compartment. Provided that the flooding is not too rapid such an investigation will normally involve entering the compartment-taking all the proper precautions when entering an enclosed space (see Chapter 21)-and searching for the source of the leak. When the leak has been found, the problem can be assessed and the correct action chosen.

Interpretation of high soundings in a cargo space: When increased soundings are found in a cargo space loaded with bulk cargo there are a number of possible explanations and each should be considered. The water may have drained from the cargo or leaked through the hatch covers. It may have entered through an unbattened access hatch or an uncapped sounding pipe. Water may have leaked through a fracture in the deck or the hatch coaming or through a damaged ventilator.

It is regrettable that officers of most ships have no accurate idea of the capacity of the hold bilge wells.

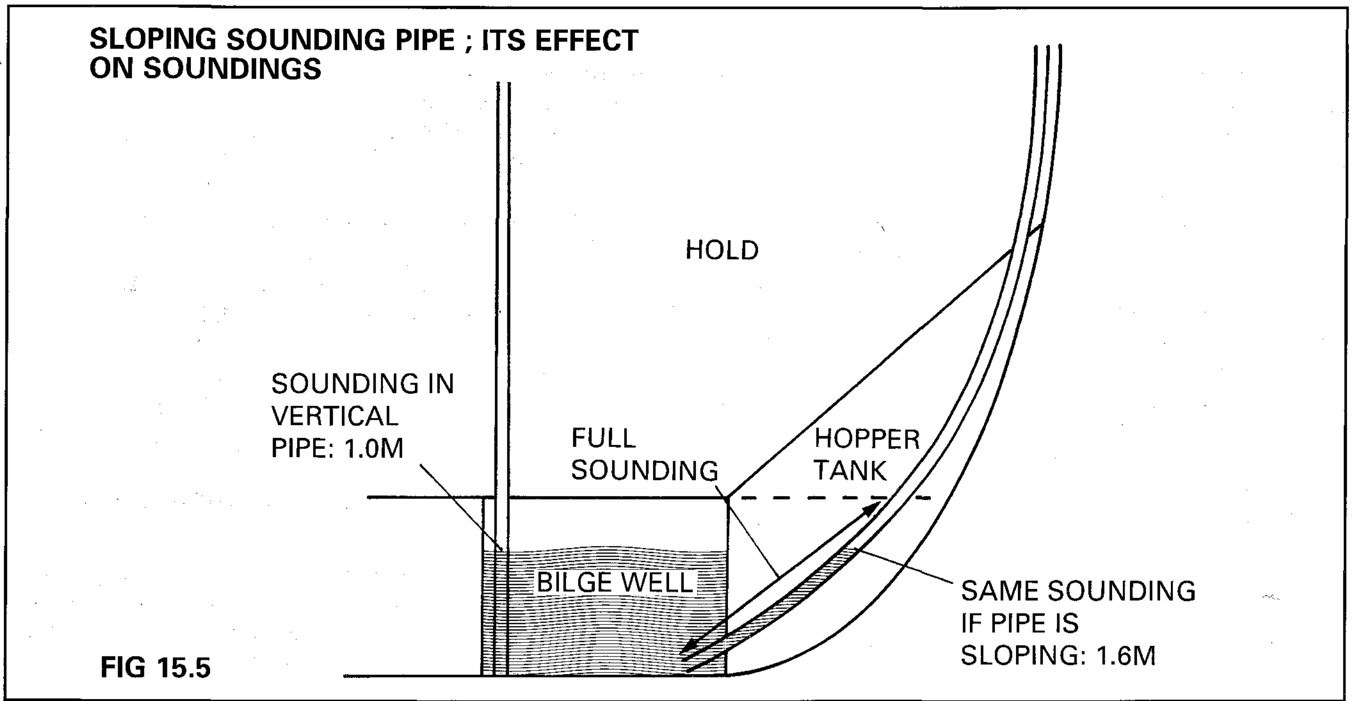
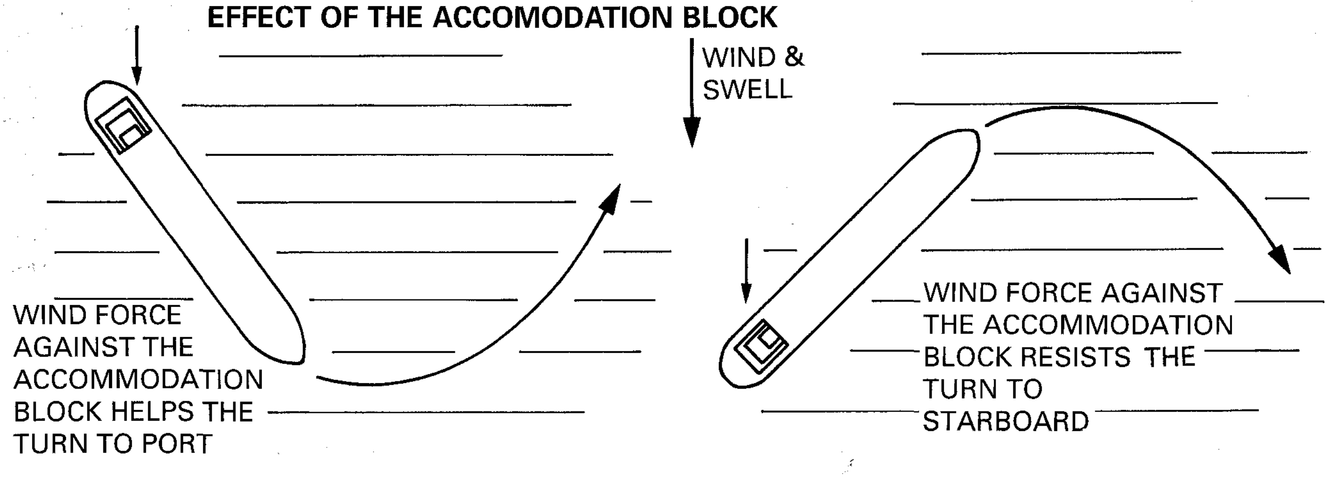


FIG 15.5

FIG 15.6 TURNING THROUGH THE TROUGH: EFFECT OF THE ACCOMODATION BLOCK



This means that they cannot say whether an increase in sounding of 0.5 metres represents 1 tonne of water, or 10 tonnes. That makes it more difficult to assess the significance of any increase in hold bilge sounding. The solution to this is simple. Measurements should be taken when the holds are empty to prepare simple calibrations. Of greatest value are the sounding of the bilge when full and the approximate tonnage of water contained by the bilge when full.

When preparing calibrations for the hold bilge wells two important points must be remembered. If the sounding pipe does not run vertically the actual full sounding will be greater than the vertical depth of the bilge well (Fig. 15.5): it is the actual full sounding which is required, since that is what the sounding rod measures. On some ships a number of the bilge wells may have exactly the same dimensions, but every one must be inspected in case any are different. Details of design near the engineroom or in a ballast hold, for example, sometimes require one or two bilge wells to be of a different shape and size to the others or to have the sounding pipe positioned differently and soundings will be very misleading unless this is known.

High soundings caused by drainage from cargo: Aboard a ship which is well operated and well maintained the most likely reason for an increased hold bilge sounding is that water has drained from the cargo into the bilge. If there has been a similar increase in most or all of the bilge soundings this suspicion will be a virtual certainty, particularly if the cargo is known to be self-draining. Water is reported to drain from most mineral and coal cargoes during the course of a long voyage with consequent weight losses of 1 per cent total weight of cargo or more. In a Cape-sized vessel carrying about 22,000 tonnes of iron ore per hold the water draining from the cargo in one hold would average 5 tonnes/day during a 40-day voyage if the 1 per cent figure is used. Water will also drain from a grain cargo which has been sprayed with a wet fumigant during loading.

When water does drain from the cargo there are two important requirements. The water must be pumped out of the bilge and not allowed to flood the hold, and the tonnage of water removed must be recorded. The reason for removing the water is to prevent increased corrosion of the tanktop and to reduce difficulties for the trimmers when discharging. It must also be remembered that once the water has filled the bilge well and flooded back over the tanktop, it is much more difficult to be sure how much water the hold contains. Flooding of the hold from a leak would then become more difficult to detect. For all these reasons the bilges must be pumped as frequently as is necessary to maintain them at a safe level-no more than half full.

It is advisable to keep a record of the tonnage of water discharged from the hold bilges, as recommended by the *UN Draft Survey Code*[60]. This can be done by taking soundings before and after each pumping of the bilges if calibration tables for the bilge wells are available, or by pumping all the contents of the hold bilge wells into a holding tank where they can be sounded before being pumped overboard. Such a record, if kept in a seamanlike and professional manner and signed by master or senior officer, will be evidence of the tonnage of water discharged and will explain apparent loss of cargo weight.

High soundings due to leakage into hold: When one or several soundings are found to be rising for no obvious reason, a problem must be suspected and the hold must be investigated for a leak. Whether the hold can be entered will depend upon the amount of space occupied by the cargo and the safety of the operation from the point of view of shifting cargo and hazardous gases. If the hold can be safely entered, taking all the precautions required for entry into a confined space, it may be possible to find an explanation for the flooding. Evidence of water flowing into the hold may be detectable in the cargo beneath hatch covers or ventilators or below a fracture in the steelwork of deck, coamings or ship's sides.

If the hold cannot be entered, a thorough external inspection should be made of the boundaries of the compartment in search for any fitting which is improperly closed or damaged. If the sounding is found to increase whenever the vessel ships water on deck, a leak at deck level should be suspected. If the flooding continues at the same rate, or an increasing rate, at all times it suggests that the damage is below water level. By using all the information available the most likely explanation for the flooding can be found and appropriate action can be taken.

High-level bilge alarms: When high-level bilge alarms are fitted and working as intended they provide a useful service to back up the daily soundings and to provide for occasions when adverse weather prevents the taking of soundings. High-level alarms will give prompt warning if hold flooding starts suddenly and proceeds rapidly. However, high-level alarms may not be fitted or may be out of order. Each high-level bilge alarm should contain a delay circuit which prevents the alarm from sounding continually when the water level is low but the ship is rolling heavily. If no delay circuit is fitted the alarm will sound continually during heavy weather and is likely to be switched off. If it is switched off for this reason the sounding must be regularly checked by other means.

High soundings detected by hull stress monitors: It is claimed that hull stress monitors will detect flooding of a bulk carrier because flooding will cause a change in the ship's average level of longitudinal stresses. When an observer at sea notes that the vessel is becoming more heavily loaded there is only one likely explanation: flooding is occurring.

Testing of bilge water for acidity

Cargoes such as high sulphur coals, iron ore, sulphur and salt produce corrosive liquids when wet and can do heavy damage to the fabric of the hold. When cargoes which may be corrosive are being carried the hold bilges should be tested regularly for pH (acidity). This procedure is described in the section of Chapter 19 devoted to the carriage of coal.

Cargo temperatures and sampling of air in holds

When carrying some cargoes such as coal and grain the temperature of the cargo must be obtained regularly to detect signs of heating. Temperatures are usually obtained from thermometers lowered into the sounding pipes on the port and starboard sides at the after end of each hold. An additional temperature pipe may be sited beside the hold ladder at the fore end of the hold. The most accurate and reliable readings will be obtained by making sure that the thermometers are lowered to a level which is well below the surface of the cargo and that they are left in position for several minutes. Where possible thermometers should be left in place permanently and withdrawn rapidly when readings are required.

Mercury thermometers are considered to be less satisfactory for taking cargo temperatures unless fitted with a maximum temperature indicator and reset before the taking of each reading, and one authority[59] recommends the use of suitably calibrated pyrometers.

When carrying coal it is necessary to test the air in the holds for hazardous gases. This process, like the taking of temperatures, is fully described in that part of Chapter 19 which describes the carriage of coal cargoes.

Fumigation to monitor

If the cargo was fumigated before departure from the loading port and if fumigation is continued in transit, regular checks should be made for leakage of the fumigant for so long as it remains active. (Fumigation is described in Chapter 21.)

Cargo lashings to check

Bulk carriers are required from time to time to carry cargoes which are secured with lashings. Steel coils carried below decks and sawn timber and logs on deck are cases in point. When cargoes are lashed a regular routine of inspecting the lashings daily, or more frequently, is essential. The frequency of the inspections must be increased early in the voyage before the cargo has setded, in bad weather and at any time when each inspection finds noticeable looseness in the lashings.

Lashings can become loose for a variety of reasons. If the ship is pitching and rolling heavily lashings will be stretched as the cargo is accelerated first in one direction and then in another. Wet logs will shrink significantly as they dry out. The cargo will settle as the ship works. Movement and vibration can cause fastenings to slacken or disengage if they have not been locked.

Any slackness in the lashing system will allow cargo to move and once it can move it will further damage the lashings and readily break adrift. It is essential that lashing systems are inspected frequently and thoroughly and that lashings are efficiently retightened as they become slack. When it is necessary to inspect and tighten cargo lashings on deck or in the holds in bad weather, the ship must be hove-to and the inspection must be carried out with the precautions described below.

Inspections

Inspections in good weather: During a loaded voyage a bulk carrier has a low freeboard and is likely to ship spray and seas on deck and over the hatches even during moderately adverse weather. This calls for a high level of alertness from the master and his officers to ensure that ship and cargo are brought safely to their destination.

In good weather it is prudent for the chief mate to carry out an informal inspection of the decks at least once a day and to satisfy himself that all is secure on deck before the end of the working day. Storeroom doors, access hatches and manhole covers if left open during the night can lead to flooding, damage or even, in extreme cases, the loss of the ship if the weather worsens.

Inspections during rough weather: During rough weather the blows which a ship receives from the sea when the bow strikes the swell and when waves are shipped over the decks and hatches can cause damage to her structure and can loosen fastenings and fittings or break them adrift. The ship's violent motion can cause cargo, stores and spares to shift or break adrift. Damage of this sort can be disastrous and every effort should be made to ensure that the ship is all secure.

Because conditions on deck are likely to be hazardous during rough weather an inspection will require organisation and planning. Wherever possible it should be undertaken during daylight hours. A procedure which can be recommended is for the master to take the bridge, sending the chief mate, bosun and several seamen to make the inspection. The inspection party dress in clothing suitable for heavy weather and equip themselves with one or two VHP radios, and with hammers, crowbars and such other tools as they anticipate they will need to tighten dogs, cleats, brakes and lashings.

When ready to commence the inspection they report by VHF radio to the master on the bridge, who is also equipped with a walkie-talkie. The master then heaves-to the ship by reducing speed and/or altering the heading as required to provide a deck which is reasonably steady and shipping no water. It is worth waiting for five or ten minutes (or longer on a big ship) for the changes in speed and heading to take effect to ensure that the ship is well hove-to and the decks are safe for the inspection party. When satisfied the master will inform the inspection party which is the lee side and will instruct them to proceed.

Walking the length of the foredeck on the lee side and also inspecting between the hatches, the inspection party will check that hatch cover cleating is all tight and access hatches properly battened down. Loose fittings will be refastened and damaged items inspected and the damage assessed. If the ship possesses masthouses they will be checked for leakage or for items broken adrift. Soundings located on the lee side of the foredeck can also be taken.

The forecastle spaces of a bulk carrier are particularly vulnerable to flooding. They will be inspected and the forecastle high level bilge alarm, if fitted, will be tested. The proper securing of the anchors will be confirmed, as will the sealing of the spurling pipes to prevent water from flooding the chain lockers. Forepeak and chain locker soundings will be taken.

When all is secure in and on the forecastle, the chief mate will report this to the master who will decide whether it is safe for the inspection party to inspect the remaining side of the foredeck. Before this can be done safely it may be necessary to put the weather on the other bow and whilst this is done the inspection party will either remain within the shelter of the forecastle or will have returned aft to the accommodation. The inspection of the second side of the foredeck, when it can be undertaken with safety, will be similar to the inspection of the side first inspected.

Hold inspections in rough weather: In addition to the inspection of deck and storerooms described above it will be necessary to inspect the holds if a cargo such as steel products is being carried and may have broken adrift or if the possibility of flooding is feared. Where possible inspections in bad weather should be avoided because of the hazards created by a rolling ship and men who are encumbered with heavy clothing, but when an inspection is necessary the normal safety procedures for entering an enclosed space must be followed. The inspection is likely to be a slow process, though time will be saved if the inspection party has a really powerful torch and much of the hold can be viewed from the access ladder. When an inspection is undertaken during bad weather and it is necessary to heave-to, these facts should be recorded in the deck log.

Conduct of loaded voyage in rough weather

Condition of a loaded bulker: The condition of a loaded bulker depends to a large extent upon the cargo she is carrying, but one or two general remarks apply. In the loaded condition her propeller and forefoot will normally be well below the surface and her freeboard will be small. As a result she is particularly vulnerable to damage caused by green seas breaking on deck. She will probably be trimmed approximately even keel. If she is loaded with a high-density closeweight cargo such as ore or concentrates she will be stiff. If carrying coal her stability will be comfortable-neither too stiff nor too tender. If loaded with grain she will be tender, and if carrying timber she will be tender and quite possibly not down to her marks.

Movement in a seaway: A ship's behaviour in a seaway depends on the size and shape of the ship and the type of wave system through which she is passing. The factors which affect the ship's behaviour are[66] the significant wave height, the mean wave period, the directional energy spread (which measures whether the waves are all going in the same direction or are fanning out) and the speed and direction of the wind and current. Other significant factors are the ship's size, her form, her condition of loading, and her speed and heading relative to the waves.

As is well known to most seamen, the only factors in the above list which the navigator can alter are the ship's speed and heading, though it may be possible to make some modest alterations to her condition of loading by adjustment to bunkers and possibly to ballast.

When rough weather is met the master must consider its effect upon his ship and upon the cargo she carries. He must also consider the safety of her crew, particularly when they are required to go onto the open decks and into the holds to carry out inspections and to tighten cargo lashings.

Ship slowed by adverse weather: When a loaded bulk carrier meets a swell from a direction somewhere forward of the beam her speed will fall, even though her engine settings remain constant. The warning given by this forced reduction of speed must not be ignored. The size of the ship and the distance of the bridge from the bows may conceal the violence of the slamming which occurs when the bows meet the swell and may hide the strength of the water shipped over the forecastle, maindeck and hatches, but a bulk carrier can suffer serious damage when forced through adverse weather.

A guideline proposed by The Nautical Institute for this situation is that when adverse weather causes a speed reduction of 25 per cent (for example, from 12 knots to 9 knots) with constant engine settings, the revolutions per minute (RPM) should be substantially reduced to avoid damage from forcing the ship into the weather.

The damage which can be expected if this guideline is ignored includes the setting-in of shell plating around and beneath the bows and damage to fittings on the forecastle deck and main deck and to hatch covers.

Ship moving violently: Violent movement can take the form of pitching when the swell is ahead, rolling when the swell is abeam and a combination of pitching and rolling (a corkscrew motion) when the swell is at an angle on the bow. When moving violently a bulk carrier's complex structure is comparatively sensitive to cracks developing[66]. Damage from sloshing is also a theoretical danger but is unlikely in practice on the loaded voyage when most, or all, ballast tanks are empty.

When a bulk carrier pitches, she is exposed to longitudinal stresses as successive swells pass beneath her, with the risk of fatigue cracks developing. When the vessel corkscrews, torsional stresses are caused. Stress concentrations may occur around very large hatch openings. Violent rolling causes rapid pressure changes (panting) in the side shell plating which may weaken the side shell structure. Heavy rolling may also lead to cargo shifting or breaking adrift.

Any motion which occurs as a result of swell from abaft the beam will be much less violent than that caused by swell from forward of the beam, because swell from abaft the beam approaches a moving vessel at a slower speed.

A ship which is pitching, rolling or corkscrewing violently is liable to suffer structural damage. To avoid damage speed should be reduced and/or course should be altered until the ship's motion eases. This action will comply with The Nautical Institute's guideline (see above), since the ship's speed is certain to have been slowed by the motion.

Altering course or speed: When a ship's motion is violent or she is seriously slowed by adverse weather, the master can choose to ease the motion by reducing speed or by altering course or by a combination of both. When the swell is coming from right ahead, a reduction in speed is likely to be more effective, since a large alteration of course would be needed to put the swell well on the bow and that would result in a lot of extra distance steamed. When the swell is already 20-30 degrees on the bow a smaller course alteration may be sufficient and may be preferable to a reduction in speed.

Alterations of course and reductions of speed in response to bad weather will be the smallest necessary to make the ship's movements safe. The master will continue to look for signs that the weather is improving, permitting him to return to the original course and to full speed.

Heaving-to: A ship is said to be hove-to when she has been reduced to a slow speed through the water and brought on to a heading on which she lies comfortably. When hove-to there is no attempt to proceed on the voyage and the ship remains almost stopped over the ground. When hove-to it is advisable to adopt hand steering. A helmsman who is aware of the weather the ship is meeting and the effect which it has on the ship's heading can steer the ship at slow speed with fewer helm movements than an autopilot would require, and can find the heading on which the ship settles most comfortably.

Bulk carrier masters will heave their ships to when crew members are going on deck in bad weather or when exceptionally bad weather is met. The normal attitude for heaving-to is with the vessel's head 20-30 degrees from the direction of the swell and with the engines running at slow ahead, with engine revolutions as for a speed of about 7 knots, which is sufficient to maintain steerage way. The wind normally comes from the same general direction as the swell and loaded bulk carriers, with their accommodation aft, have little difficulty in remaining on the chosen heading. When hove-to with the weather on one bow there is still the danger that green seas will slop aboard on the weather side and spray will continue to be shipped, but the water will arrive less violently than when the vessel is making way.

It sometimes happens in rough weather that the speed of a bulk carrier is so reduced by the adverse conditions that she makes no noticeable progress across the ocean for a period of hours or for several days. In those circumstances she is effectively hove-to, but without having made a deliberate decision to heave-to.

Running before the swell: If the swell is on the quarter during bad weather the ship's motion will usually be much less violent, although it is necessary to beware of a high fast-moving swell which can catch the vessel's stern and push her off course, where she will roll heavily. This can be avoided by reducing speed to well below that of the swell. The only other circumstance in which it is necessary to heave-to with the weather on the quarter is if crew members are required to go on deck or into the holds.

When the ship is running with the weather, water is likely to slop onto the main deck on the weather side. Before men go on deck it is advisable to reduce speed, put the weather 20-30 degrees on the quarter, and to ensure that the men remain on the lee side of the deck to avoid water which may be shipped on the weather side. In this attitude the vessel can be regarded as being hove-to with the weather on the quarter.

When rough weather is coming from a position abaft the beam, special care must be taken to secure doors, skylights and hatches facing aft. These are normally left open, but with the weather astern green seas can unexpectedly be shipped, resulting in flooding of machinery spaces, storerooms and accommodation.

Turning through the trough: When a ship is manoeuvring in a heavy swell the most alarming and hazardous manoeuvre is turning from a heading with the weather on the bow to one with the weather on the quarter or vice versa. When lying in the trough of a heavy swell the vessel is liable to roll very heavily. Although this puts no great stress upon the ship's structure in the short term it can cause cargo to shift and create havoc in accommodation and storerooms. For these reasons the manoeuvre should be avoided whenever possible.

Where it is essential to turn the vessel through the trough the master should first inform the ship's company (particularly the engineroom and galley) of the intended manoeuvre, and the likelihood of heavy rolling. When turning to bring the weather on to the bow the accommodation block, acting as a sail, will assist the turn. A turn to put the weather on the quarter will be more difficult, as it will be necessary to force the stern with the accommodation block into the weather. (Fig. 15.6)

The master should study the wave patterns for some time in the hope of identifying a period of lower swell. The turn should be commenced at the lowest speed which gives steerage way. The ship should be turned with the helm hard over, and with the use of short bursts of full speed ahead on the engines. This will cause the ship to turn quickly without gathering speed. If the ship does fail to swing through the trough and remains lying beam on to the swell she will stop pitching, which should allow her speed to increase enabling her to complete the turn.

Reporting

During a loaded voyage the master will be required by owners and/or charterers to submit routine position reports and ETA messages at specified intervals. Fuel consumed, weather experienced, speed made good and engine revolutions and slip may also be required. He may also be instructed to provide reports of cargo temperatures and of bilge pH values and hold gas readings when sensitive cargoes such as coal are carried, even if the report is no more than 'all normal'.

It is desirable that ships should also participate in voluntary reporting schemes, such as the worldwide AMVER scheme, and other regional schemes.

Arriving at the discharging port

When arriving at the discharging port the hatches should remain securely battened down, except for cargo inspections, until the ship is in sheltered waters and proceeding to the discharging berth. When conditions are sheltered the hatches can be uncleated before the berth is reached so that they can be opened immediately upon berthing. When a robust cargo such as iron ore is carried it is acceptable to berth with two or three holds open, ready for an immediate commencement of discharge.

Where possible ship's officers should inspect the cargo before berthing for any signs of problems such as wetting from sweat or leakage or deterioration of grain. Such problems should be discovered as soon as possible, so that expert advice can be obtained.

Sources

22. *Code of Safe Practice for Solid Bulk Cargoes.* International Maritime Organization. 1991.

49. Thomas, Q.Q. Agnew J. Cole K. L. *Thomas' Stowage - The Properties and Stowage of Cargoes.* Brown, Son & Ferguson Ltd. 1985.

59. Lower-Hill, B.J. *Lloyd's Survey Handbook* . Lloyd's of London Press Ltd. 1991.

60. *Code of Uniform Standards and Procedures for the Performance of Draught Surveys of Coal Cargoes.* United Nations Economic & Social Council. Economics Commissions for Europe Committee on Energy, Working Party on Coal. 1992.

66. Robertsson, S. and Lindemann, K *An Introduction to Ship Handling in Rough Weather.* Veritas Report No. SI-0215. DnV. 1981.

88. Moens, W.D. 'Optimal Routeing of Ships'. Symposium on Weather Routeing of Ships, London. 1970.

89. Mackie, Captain G.V. 'Weather Routeing of Ships'. *The Marine Observer.* 1981.

90. *Ocean Passages of the World.* 4th Edition. NP 136. Hydrographer of the Navy. 1987.

91 *Metroute: Worldwide Ship Routeing Services.* The Meteorological Office, Bracknell. 1991.

94. Meijers, J.H.C. 'Some Economic Aspects of the Routeing of Ships'. *Trans. IMarE,* 1980.

CHECKLIST-Routine procedures for the loaded voyage

- ☐ Have hatches and mooring lines all secured well before the open sea is reached. Secure anchors when no longer required.
- ☐ Choose and follow the most suitable route for the voyage, taking account of the factors mentioned in the chapter.
- ☐ Determine whether the cargo requires ventilation.
- ☐ Follow any special instructions for ventilation.
- ☐ Take dewpoint readings and ventilate when dewpoint in hold is higher than dewpoint outside.
- ☐ Stop ventilation when shipping spray over vents.
- ☐ Log dewpoint readings and times of stopping and starting ventilation, with reasons.
- ☐ Take a full set of soundings every day and study them for any unexplained increase or reduction in sounding.
- ☐ Investigate promptly any unexplained changes in soundings.
- ☐ When water drains from cargo the bilges should be pumped before they fill, and a record should be kept of the tonnage of water removed.
- ☐ Test hold bilges regularly for acidity (pH) and pump them dry if they are found to be acid.
- ☐ Take cargo temperatures and test air in holds daily when required for the cargo being carried.
- ☐ Check and tighten cargo lashings daily or more often.
- ☐ Inspect the decks daily and ensure that storerooms, hatch accesses, hatch covers and manhole covers are secure at the end of the day and before the onset of bad weather.
- ☐ In bad weather inspect the decks daily, taking all necessary precautions to ensure the inspection is safe and thorough.
- ☐ When the ship is slowed by bad weather, reduce the engine speed or alter course.
- ☐ Follow safe procedures for heaving-to with the weather on the bow or on the quarter and for turning through the trough.
- ☐ Make routine position and ETA reports as required.
- ☐ Report cargo temperatures, bilge pH readings and gas readings if required.
- ☐ Clear anchors, prepare mooring lines and prepare the ship as advised in Chapter 6.
- ☐ Inspect cargo for problems immediately upon arrival.
- ☐ Prepare hatches for discharge immediately upon arrival.

CHAPTER 16

THE DISCHARGING PERIOD

Shipboard organisation during discharge, routine procedures, on first arrival, liaison with the discharging staff, the discharging/ballasting programme, ballasting, discharge by continuous unloading, grab, Cavaletto, vacuvator or ship's gear, care for cargo, the search for and repair of stevedores' damage, crew work

Shipboard organisation during discharge

THE DELIVERY of cargo to the receiver in the discharge port and the importance of the bill of lading is fully discussed in Chapter 14.

The tempo of cargo discharge is normally less hectic than that of the loading. The likelihood that a misjudgement or a brief period of inattention will result in the ship being wrongly loaded is absent: the requirement for a satisfactory discharge can be met by alertness and careful attention to the ship and the cargo at every stage of the discharge.

The supervision of discharge will require a junior officer (second or third mate) on duty at all times as officer of the watch (OOW), with the chief mate monitoring events and intervening whenever necessary to ensure that the discharging programme is observed, standards are maintained and the work is progressed. The master will be actively involved with the discharge if his officers are inexperienced, or if problems arise. Otherwise he will be able to give his attention to other matters.

Routine duties for the officer of the watch

Described below are a number of particular duties for the officer of the watch (OOW) whilst the vessel is discharging. In addition, the OOW must ensure that the moorings and gangway are tended, pollution is avoided, the weather is observed and recorded, and full records are maintained. These requirements are described in Chapter 12, for the loading period. In these respects the discharging period is no different.

The OOW must also ensure that hatches are always secured to prevent them from moving, whether open or closed. Hatches must only be moved after the coamings have been completely swept clear of cargo residues and must not be moved when any quantity of spilt cargo is lying on them. (The routine closing of hatches is described in Chapter 4. Safe procedures for working cargo are summarised in Chapter 12 and discussed in Chapter 21.)

On first arrival at the berth

When planning the arrival at a discharging berth it is useful to know if a draft survey or cargo survey is to be held, and if discharge is to commence on arrival. Where possible it is normal to open the covers of some hatches before berthing. Some charterparties and charterers may instruct that all hatches are to be opened before berthing, and these instructions should be followed provided that it is safe to do so and will not result in damage to the cargo.

If the hatch covers have been opened, a draft surveyor, if employed, can commence his work unaffected by any change of trim caused by moving hatch covers, and stevedores can make a prompt start with the discharge if they are ready to do so. Hatch covers can only be opened when the ship is in the sheltered approaches to the berth and when weather conditions permit. If water can spill from the hatch covers and damage the cargo, it is essential that free water is swept from the covers before they are opened. Rubber squeegees are very effective for this process.

The chief mate should always calculate the deadweight from the drafts on arrival to confirm the quantity discharged for the ship's records, regardless of whether or not an independent surveyor is appointed. If there is no formal draft survey he will rely upon his experience and knowledge of the ship to obtain accurate readings of ballast strippings and bunkers at the first convenient opportunity, not necessarily exactly at the time of berthing.

The master and his officers should always give high priority to an inspection of the cargo on arrival for any signs of damage from leakage, condensation, shifting, infestation or other cause. Where possible such inspection should be made at the anchorage or during the river transit. Ship's officers should make it a point of honour to find any damage before it is discovered by other parties. Minor damage such as slight leakage through the hatch covers should be fully recorded and noted for prompt repair. More substantial damage which seems likely to result in a cargo claim should be immediately reported to the vessel's owner with a view to arranging for the attendance of a P&I club surveyor, who will advise on the best way to minimise the claim.

Liaison with discharging foreman

Good communication must be maintained between the discharging foreman and the chief mate and officer of the watch. Matters for discussion will be the discharging/ballasting programme, airdraft, stevedores' damage, trimming, care of ship's cargo gear if used, and possible causes of interruption of cargo work. Also of interest will be the stevedores' working hours, any specialised equipment or procedures to be used, and the estimated time of completion. The ICS *Ship/Shore Safety Checklist*[85] can be used for the exchange of basic safety information.

If the ship is required to shift along the berth, discharge must stop and cargo gear must be lifted clear of the ship before the move takes place.

The foreman should be warned if cargo has been spilt on deck, so that trimmers can collect and discharge it. The chief mate should always insist on major spills being cleaned by trimmers to provide a safe access, as coating of some cargoes on a deck wet from rain or dew can make it like an ice rink! In some ports the trimmers will refuse to remove cargo spilt on deck, leaving such residues for the crew to clean at sea, but the attempt should be made to demand that they remove the spillage.

Discharging/ballasting programme

The discharge and ballasting should be planned to ensure that longitudinal stresses will not be exceeded at any stage, there is always sufficient underkeel clearance and airdraft, and the vessel may leave the berth at any time. The preparation of the discharging/ballasting programme, following the same procedures as are described in Chapter 9 for the loading/deballasting programme, is normally the work of the chief mate. He will deliver copies of the completed programme to the stevedore foreman, and to the officer of the watch, and ensure that it is understood. The Nautical Institute's Cargo Operations Control Form (Appendix 9.3) is suitable for this purpose.

When discharging a full cargo of a single commodity at a single berth, the planning normally presents no problems and can be done before berthing, provided that the method of discharge is known in advance. If the cargo consists of several grades or consignments, or if the number of discharging grabs or type of discharging equipment cannot be forecast, it may be impossible to determine which grade or grades will be discharged first. In those circumstances the planning of the discharging and the ballasting must wait until arrival and must then be planned in conjunction with the stevedores. Simple rules of thumb (e.g., do not discharge any hold fully until all holds are half empty) are better than no rules, but are not sufficient to ensure that longitudinal stresses are never exceeded. Every stage in the discharging programme must be calculated and the stevedores should be provided with a full discharging/ballasting programme.

Preplanning is only possible when the exact nature of the equipment to be used for discharge and the receivers' requirements regarding sequence of delivery of different marks are known in advance. Provided that a safe discharging/ballasting programme to meet the ship's and the receivers' requirements can be calculated within the space of two hours or so, as it normally can, there should be no need to delay the commencement of discharge until the programme is produced. No ballast should be taken in the early stages of discharge, and discharge from a small number of holds cannot be excessive in the short time required to produce the programme. A sample discharging/ballasting programme for a Capesized bulker is at Appendix 9.3.

If the early completion of the discharge of a particular hold is required for the purposes of survey, repair, cleaning, ballasting or other reason, this requirement should be included in the discharging/ballasting programme and explained to the stevedores.

It may be difficult to ensure that the discharging/ballasting programme is complied with. The stevedores, presented with open holds, may ignore the programme they have been given and move from one hold to another to suit their own convenience. Even if they follow the programme in principle they may be unable or unwilling to keep strictly to the tonnages stated. At a berth where three or four cranes and grabs are used a draft survey made by the ship's officers can provide the total tonnage remaining aboard, but the tonnage in a particular hold can only be estimated.

To assist compliance the discharging programme should be a simple one, relying upon simple proportions which are easy to judge approximately. For example, each hold should be 50 per cent discharged and then fully discharged. This allows officers to estimate more easily whether or not the programme is being followed by the stevedores. Towards the end of discharge, as the tonnages remaining become small, the possibility of exceeding stress limits becomes unlikely and strict compliance with the discharging programme is less important.

If three or four cranes are used for discharge it is unusual for longitudinal stresses to cause any problems, because the cargo can be discharged fairly evenly. Stress problems are more likely if there are only one or two discharging cranes.

Because discharge is slower than loading, the chief mate has more time to revise the plan if that becomes necessary because of a change in the number of cranes available. Ballasting, too, presents fewer problems than deballasting and can be reorganised more easily.

A safe discharging/deballasting programme with low levels of longitudinal stress is only difficult to achieve if the discharge is very rapid and uses only one or two unloading devices.

Ballasting

Ballast tanks may be punctured by cargo gear during discharge, and the hopper sides should be inspected where possible before the tanks are ballasted to note damage and avoid pumping ballast water through a punctured tank wall into the cargo. In addition, aboard ships such as the *Regina Oldendorff* where the topside ballast tanks can be used for cargo, the tanks should be checked to ensure that the covers for the feeder ports or dumping manholes are securely closed. If they are not properly closed they will release ballast water into the cargo hold.

Subject to draft restrictions and any other special requirements the ballasting should be planned to start when the discharge is about 25 per cent completed and should be complete well before completion of discharge. The ship's draft should be kept as deep as possible, thereby keeping the airdraft low. A large airdraft slows the discharging rate, and may make it impossible to lift the bulldozers suspended below the grab into and out of the holds.

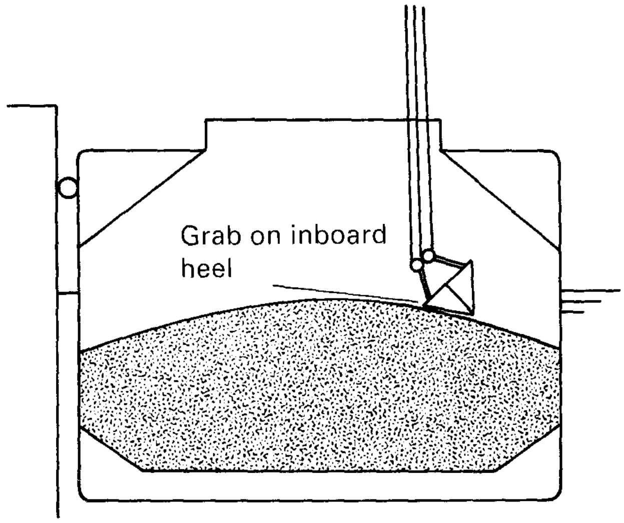
Some large bulk carriers have holds which can be partly ballasted in port to reduce the airdraft. These are not true ballast holds and cannot contain ballast water at sea. They do not have the strength to be fully ballasted, nor the hatch cover fastenings to resist the sloshing of water in the hold.

The vessel should be kept upright throughout discharge and ballasting. It becomes difficult or impossible to open and close hatches and to use shipboard cranes against a heavy list or trim. (Ballasting is fully discussed in Chapter 7.)

The discharge

Continuous unloading: Discharge by continuous unloading methods such as pneumatic hoses,

HEEL DIGGING



The grab is swung outboard as far as possible and landed on the cargo in the closed position. The operator then opens the grab. The inboard heel of the grab bites into the ore, but cannot move freely so the outboard jaw opens out further to the outboard side and the driver can manoeuvre the whole grab nearly a complete open jaw width further.

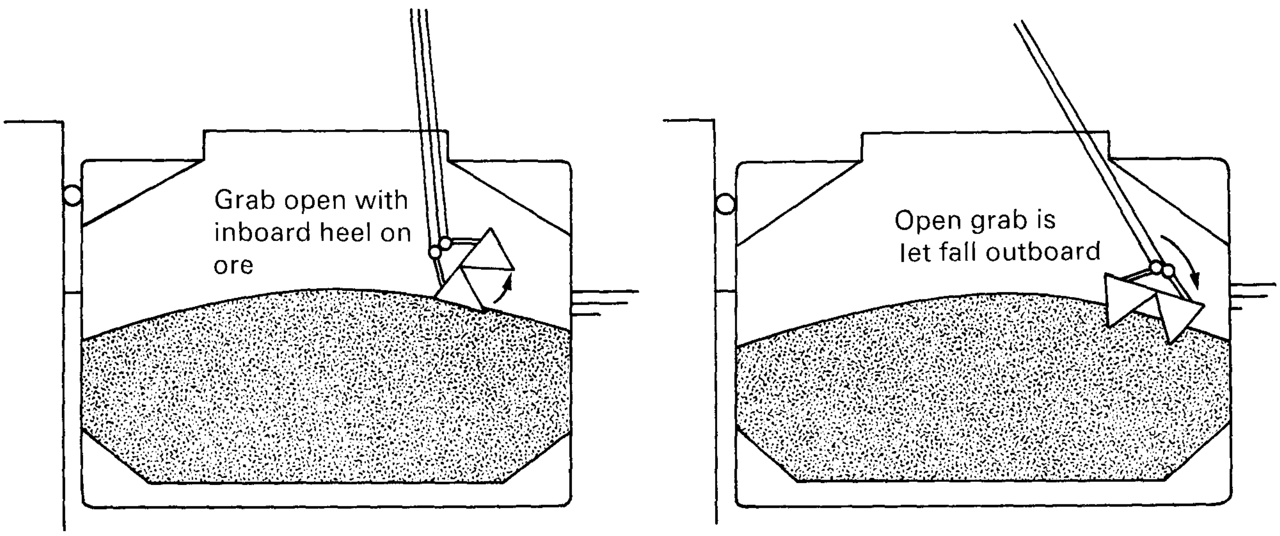


FIG 16.2

unloading methods such as pneumatic hoses, Archimedes' screw or bucketwheel unloader calls for little comment. By a variety of methods these systems extract a steady flow of cargo from the hold through an enclosed system to the shore. Normally the only source of problems is accidental contact between the unloading equipment and the ship's structure. To prevent damage from contact, the equipment must be operated with care and the ship must not be allowed to surge in the berth. Some continuous unloaders have the operator's cab close to the business end of the system in the ship's hold, and this is to be welcomed as it reduces the likelihood of damage to ship or equipment as a result of accidental contact between them.

Grab discharge: Discharge by grab is by far the most common method of discharging bulk cargoes because of the flexibility of the system, despite the number of theoretical disadvantages from which grabs suffer[86]. In the early stages of the discharge of a cargo such as coal which fills the hold, plenty of cargo is available to the grab in the hatch square, and work can proceed at maximum rate whilst the first 20 per cent of the cargo is discharged. This 'creaming' or 'cream digging' is followed by 'free digging' until 50 per cent of the cargo has been discharged. During free digging the cargo is still accessible but is deeper in the hold, so the discharging rate falls as it continues to do during each stage thereafter.

The cream digging and free digging stages will be reduced if the crane does not have sufficient outreach to plumb the outboard side of the hold. When that occurs, there are three methods[37] which the crane driver can use to reach the cargo on the outboard side. He can swing the grab like a pendulum before lowering it at the limit of its swing, he can slide the grab down the sloping side of the stow, if it has not been trimmed level, or he can use a process known as heel digging, illustrated in Fig. 16.2. Stevedores prefer the pendulum method because it is quickest, but when grabbing close to the hopper tanks and tanktop they should use the heel digging method, which is less violent and more easy to control, to avoid damage.

The next stage, 'intermediate digging', requires more care as the cargo is lying closer to the ship's structure and is less accessible. The final stage of discharge is the trimming, a process which must be commenced when the hold is about 85 per cent empty, by volume. During trimming, cargo is brought from the sides and ends of the holds by bulldozers and piled in the square for removal by grab, with the final cleaning and loading of the grab being done by trimmers-men working with shovels and brushes. In some berths the bulldozers may be lifted into the holds and used at an earlier stage to push more cargo into the path of the grab and speed the discharge.

Some cargoes harden during the voyage and stick to the bulkheads in large masses forming overhanging cargo faces[87] which can be dangerous for trimmers in the later stages of discharge. When large quantities of cargo are seen to be clinging to the bulkheads during discharge trimmers should be employed to free the cargo from the bulkheads at an early stage, while the distance for the cargo to fall is small. The OOWs should be instructed to look out for cargo clinging to the bulkheads and to bring it to the attention of the foreman. Stevedores should never be allowed to land grabs or bulldozers on deck or on the hatch covers.

Discharge by Cavalletto: The Cavalletto system met in some Italian ports, uses a substantial portable gantry which is lifted aboard ship (Photo. 16.3). First, the hatch coamings are specially strengthened to receive a pair of fore-and-aft beams which are placed on them. A mobile gantry which houses grab, hopper and chute is then lifted on to the beams by a large shore or floating crane. Cargo is lifted from the hold by grab which is opened over the hopper, tipping cargo into the chute which carries it over the ship's side into barges or coasters lying alongside. The ship may be required to provide electric power for one or more such units.

The process of rigging or shifting the Cavalletto takes six-eight hours and is very labour intensive, so the number of moves from hold to hold should be kept to a minimum.

Discharge by vacuvator: Vacuvators (Photo. 16.4) are self-contained mobile suction units powered by diesel motors and usually weighing 3-5 tonnes. Their use is most common in berths where bulk cargoes are not regularly handled and in underdeveloped regions. When lifted on to the deck of a ship they can be used to discharge grain and similar cargoes into barges or into road or rail wagons on the quay. When placed on deck they should be lashed or otherwise secured in position to prevent them from taking charge and rolling across the deck if the list changes or the ship surges at her moorings. Oil leakage from the vacuvator's motor may occur and must be prevented or contained.

Discharge by ship's gear: When ship's cranes or derricks are used for discharge they are normally operated by shore drivers whose level of competence and goodwill is unknown. Their work must be carefully supervised by ship's officers to ensure that they work safely and do not misuse the ship's gear. Continuous cargo work makes a heavy load for the ship's gear and it should be frequently and thoroughly inspected and tested to ensure that all is in order, following the procedures described in Chapter 6, to ensure that the gear remains operational.

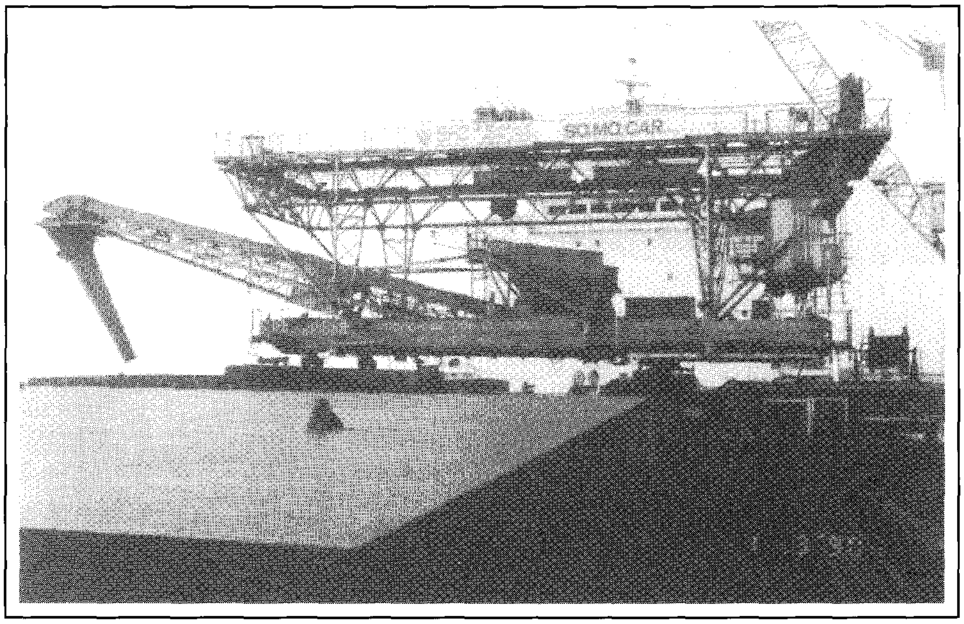
Care for the cargo

During discharge the ships' officers must be alert to ensure that the cargo is not damaged. Hatches must be covered promptly for rain or snow if the cargo must not be wetted, and breakbulk and unitised cargoes such as steel, timber and woodpulp must be correctly handled and slung. If there is excessive leakage of cargo from grabs on to the deck or the quay or into the dock, protests must be made by word and supported in writing. High winds may prevent the discharge of some cargoes because of high windblown losses, or because of unwelcome distribution of the cargo over nearby communities.

The OOW should look out for damage to the cargo from oil or hydraulic leaks from shore, or ship's, gear.

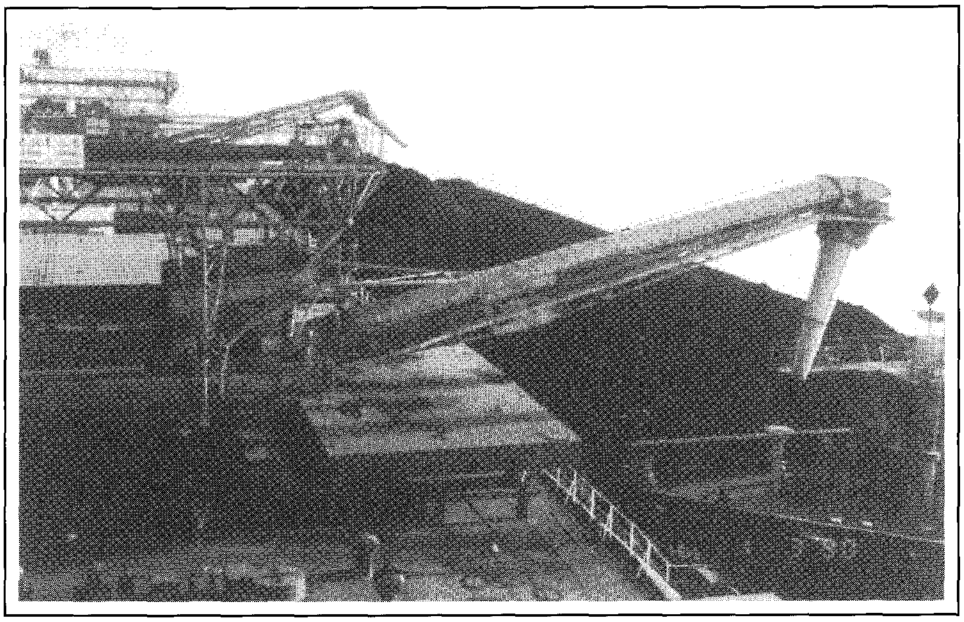
Where different parcels of cargo are carried in a single hold, officers must ensure that the stevedores find and observe the separations, whether they be in the form of coloured ropes separating cargoes of logs,

FIG 16.3 PORTABLE CAVALETTO BULK DISCHARGE SYSTEM IN USE ABOARD THE PANAMAX BULKER ASTERIKS AT TRIESTE



The system is supported on heavy beams which rest on the hatch coaming.

Photograph: Courtesy Captain Pradeep Chawla, MNI



Cargo is raised from the hold by grabs and reached the barge via the hopper and conveyor system.

Photograph: Courtesy Captain Pradeep Chawla, MNI

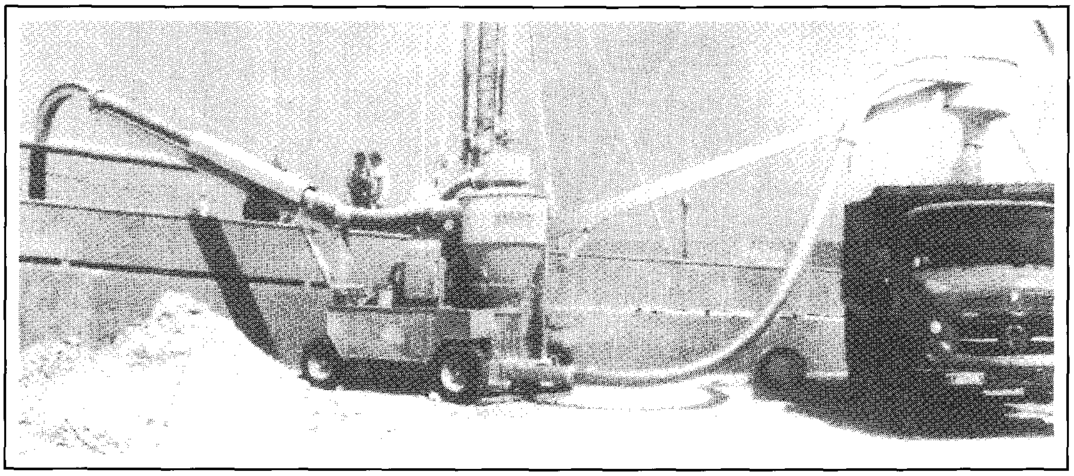


FIG 16.4 VACUVATOR IN OPERATION

Photograph: Courtesy Vigan Engineering SA.

from South Africa, or polythene sheeting or netting used between consignments of bagged cargoes. The completion of one parcel, removal of the separation and commencement of the next parcel should be observed by the duty officer to ensure that no mistakes are made and to make a record of the details. Separation material can often be saved to be reused or returned to the supplier.

Once the cargo has crossed the ship's rail it is more difficult for ship's personnel to prevent it from being damaged, but it is necessary to observe what happens to the cargo ashore. If quantities are spilt, if it is contaminated by loading into dirty trucks or water-logged lighters, or by placing on contaminated or muddy quays, if different grades are mixed or if cargo which is sensitive to moisture is left in the open, this is cause for concern because an attempt may be made, at a later date, to blame the ship for this damage. The shipowners and/or their P&I club should be informed immediately, so that a surveyor can attend to observe events, and the details should be recorded by the taking of photographs and by an entry in the ship's log book. In addition, a written protest should be issued to stevedores, agents or receivers.

Care *for the ship*

Stevedores' damage: A variety of methods for discharging ships are available. Most of them such as suction hoses, Archimedes' screws, or self-unloading by means of gravity feed to shipboard conveyor belt are used for special cargoes or ships and are unlikely to damage the ship. However, by far the most common means of discharging bulk cargoes is by means of grabs rigged on gantry cranes (see front cover photo), luffing cranes, or ships' cranes or derricks. Grabs are very strongly made from toughened materials and when carelessly used can cause considerable damage to a ship's structure.

Crane drivers must be forbidden from using grabs to strike the ship's structure deliberately to loosen cargo residues, and protests must be made, verbally and in writing, to enforce this. Crane drivers who are careless or incompetent are also likely to cause damage, and officers must insist that they work more slowly and safely or are replaced by more skilful colleagues.

Stevedores' damage form: It is necessary to find stevedores' damage as soon as possible and preferably as soon as it occurs, so that the stevedores can be held liable for the damage. The foreman or supervisor should be shown the damage, and if it was caused by carelessness or unsafe practices he should be instructed to prevent any repetition. He should also be presented with a written notice stating that his employers are liable for the damage. Such written notice is often made on a form provided by the charterer. If no such form is available the owners' form should be used, or a suitable letter can be written if no form is available. Port, date and time must be stated, and the exact location and description of the damage should be carefully entered, so that several years later the damage can be distinguished from other damage, if necessary.

Charterparties often state that the notice must be presented within 24 hours of the time when the damage occurred, so the form must be completed and presented as quickly as possible. If damage is discovered which must have occurred more than 24 hours earlier it should still be reported. Provided that there is a good reason why it was not discovered sooner the claim will still be valid.

When the stevedores' damage form has been completed it must be presented to the stevedore foreman and his signature obtained on all copies. He will retain one copy whilst the ship keeps the remainder. Stevedores show great resourcefulness in finding reasons for not signing the damage form, but their resistance must be met by determination on the part of the ship's officers. A signature 'for receipt only', or a signature denying liability is better than no signature. If no signature can be obtained the form should be endorsed with 'At (time) on (date) completed form presented to stevedore foreman who refused to accept or sign it', and a copy should be given to the ship's agent to deliver to the stevedores.

Search for damage: Stevedores' damage is sometimes very obvious as when, for example, the corner of a grab punches a hole in a topside tank and ballast water gushes into the hold, or a swinging grab swipes a derrick crutch and bends it through 90°. At other times it is much less obvious, as when the hatch coaming receives a heavy knock and is deflected 50mm or so out of true or when the damage is concealed by cargo residues. The first rule for detecting stevedores' damage is for the duty officer to remain on deck for as much of the time as possible, to observe the discharging process and to see the way in which the grab is being used. Every loud bang should be investigated, and whilst an officer is on deck the hatch coamings, visible hold areas and the surrounding superstructure such as masts, samson posts, ventilators and floodlights should be regularly viewed for damage.

Crew members and dock labourers, if consulted, can often draw attention to damage that might otherwise be overlooked and it is worth emphasising this to the crew, who may not previously have been encouraged to help in this way.

When the main grab discharge is ended bulldozers are usually lowered into the hold to gather cargo from the ends and wings and pile it in the hatch square for discharge by grab. Trimmers-men employed to shovel up the last of the cargo from the positions which the bulldozer cannot reach-will also enter the hold at the end of the main grab discharge, to assist in the discharge of the final remaining cargo. Standards of trimming vary considerably and the ship's officers should inspect the holds whilst the trimmers are working there, to encourage them to remove as much cargo as possible. This is unnecessary only if the next cargo is to be the same again, and the ship has received clear instructions that the holds do not have to be cleaned.

Residues from some cargoes cling to the sides and end bulkheads of holds and are difficult to dislodge, and a number of techniques have been developed for removing them. A widespread practice has been for grabs or bulldozers to be used to strike the bulkheads and ships' side frames to dislodge cargo, and pneumatic hammers have been used to vibrate the structure for the same purpose. It is now recognised that these practices are likely to cause fatigue and fractures in the steelwork or the welding of the ship's structure, in the steelwork or the welding of the ship's structure, even when operators are skilful, and 'masters should be alert to the risk of potential damage by such practices, and should intervene if necessary'[85]. In other words, the ship's steelwork should not be struck to dislodge cargo, as this is likely to damage the structure.

Unfortunately the situation is not straightforward. Although it is known that striking the steelwork causes long-term damage, shipowners are reluctant to forbid the procedure entirely, as they fear that this will make their ships slow and difficult to discharge and therefore unpopular with shippers. Without clear and definite orders masters are reluctant to forbid hammering, because they fear that unmanageable quantities of residues will be left in the holds for them to remove after the ship has sailed. One master with experience of this problem advises that the trimmers should be brought into the hold at an early stage to remove cargo from the bulkheads whilst standing on the cargo. If this cannot be arranged, or is not properly done, then hammering should not be prevented, but a letter of protest should be submitted before the vessel sails.

Whilst the duty officer is in the hold encouraging the trimmers to do a better job, he should take the opportunity to inspect the hold for damage, although this cannot be a final inspection. A bulldozer has the ability to damage hold fittings, and a final inspection should be left until the machine has completed its work in the hold and been lifted out.

The final inspection for stevedores' damage in the hold should ensure that no bilge gratings or manhole cover plates are missing, that all sounding pipes, airpipes and ballast lines and their pipeguards are intact, that no new indents can be seen in the plating of the tanktop, lower or upper hopper sides or athwartships bulkheads, that the ship's side frames are regular and undamaged, with brackets undamaged, and that the hold ladders and other fittings are complete and undamaged.

Some officers may be tempted to blame the stevedores in port B for the damage which they only discovered after leaving port A. This is ill advised as stevedores usually have a good idea of the damage they have caused, and any hope of co-operation will disappear if they think that they are not receiving honest treatment from the ship. If the damage is discovered by careful inspection before leaving port A and the stevedores are held liable, this problem will not arise. Where damage is suspected, but there are good reasons why it cannot be confirmed before sailing, the stevedores should be issued with a stevedores' damage form holding them liable for any damage found (e.g., after completion of discharge of a part discharged hold). The reasons why they are thought to have caused damage should be clearly stated.

Repair of stevedores' damage: Those stevedores who are well equipped and well organised usually prefer to make good any stevedore damage which they have admitted before the vessel leaves port. Provided that the repair is a competent one this is the most satisfactory outcome for the ship, but there are some dangers. If the damaged item has been made of high tensile (HT) steel it will be necessary to renew it using steel of the same quality and suitable welding materials. The master should ensure that intending repairers know when they are dealing with HT steel and should satisfy himself that the repairers are competent to undertake the work. When in doubt the owners should be consulted and it may be necessary to consult the vessel's classification society.

The owners and the classification society must be informed as a matter of course when serious damage which may affect the vessel's seaworthiness is suffered, so that suitable repairs of an acceptable standard can be completed and the ship does not sail with serious damage unrepaired.

When repairs are completed by the stevedores, they will want a signature to confirm that the repair has been made, or they will demand destruction of all copies of the stevedores' damage form. This is reasonable when a satisfactory permanent repair has been completed, but it should be remembered that further expense will be incurred at a later date if the repair is only temporary. If, for example, a patch has been welded over a hole punched in the hopper side, the stevedores' damage form should not be cancelled, but should be endorsed 'temporary repair made'.

Crew work during discharge

There are limits to the work that trimmers can be persuaded or compelled to do in the holds, and it is sometimes in the ship's interests to put crew members to work in the holds on supplementary cleaning. For example, some masters recommend placing crew members in holds at an early stage in the discharge of grain when it is safe to do so, to stand on the cargo and sweep grain from surfaces such as the flanges of deck frames high in the hold where cargo settles and is later difficult to remove.

Trimmers will often refuse to remove cargo which has fallen into hold bilge wells when a cover plate has been dislodged. If crew members remove the cargo from the bilge the stevedores will normally be co-operative about lifting it from the hold by grab, thus saving time and effort for the crew later. The same applies for completed holds. Extra cargo missed by the trimmers can be gathered by the crew and will usually be discharged by the stevedores, thus saving considerable extra effort for the crew.

As the discharge from particular holds is completed, the crew may be required to clean ballast holds before they are ballasted or in preparation for the loading of the next cargo. (The necessary procedures are described in Chapter 5.)

Sources

37. Lynch, R.J. *Steel Industry Bulk Cargoes-A Guide for BHP personnel.* BHP Transport Ltd. 1980.

85. *Ship/Shore Safety Check List.* International Chamber of Shipping. 1992.

86. Aberkrom, P. 'Grabs-A great Leap Forward'. *Bulktmns '91.* CS Publications. 1991.

87. Curline,J.R. (Editor). *Safe Loading, Ocean Transport and Discharge Practices for Dry Bulk Commodities.* The Australian Coal Association et al. 1992.

CHECKLIST-Duties of the officer of the watch in the discharging port

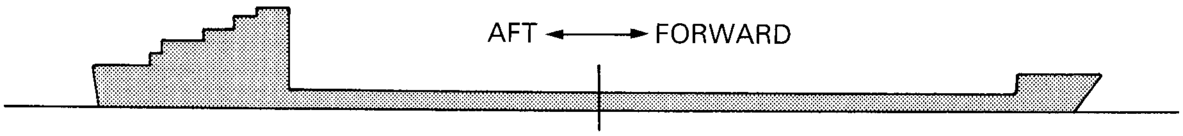
- ☐ Study and understand the discharging/ballasting programme.
- ☐ Monitor the discharge and watch the draft to ensure that the discharging/ballasting programme is followed.
- ☐ Liaise with discharging foreman regarding stevedores' damage, work of trimmers, and possible causes of delay.
- ☐ Warn foreman if cargo is sticking to hold bulkheads and trimmers are needed to shovel or brush it down.
- ☐ Ensure correct cargo is discharged and cargo is in good condition.
- ☐ Keep any list within acceptable limits.
- ☐ Monitor the ballasting to ensure no overflows occur.
- ☐ Co-ordinate and supervise the work of the crew to ensure efficiency in shifting of the ship, preparing ballast holds for ballasting, preparing holds for washing, maintaining efficiency of ship's cargo gear, and securing of holds on completion.
- ☐ Keep the discharging foreman informed of any developments, particularly of potential problems which may affect the discharging.
- ☐ Note any possible causes of damage to ship or cargo, and make every effort to prevent them.
- ☐ Note and record any damage to ship or cargo and immediately pass details to the chief mate, who will hold the stevedores responsible.
- ☐ Ensure moorings and means of access are tended as necessary.
- ☐ Record full weather observations at least three times daily.
- ☐ Maintain full written records in the port log book and/or deck log book of all relevant events and data (items as detailed in the body of Chapter 12).
- ☐ Ensure that safe procedures are followed at all times.

Duties of the chief mate in the discharging port

- ☐ Distribute copies of the discharging/ballasting plan to the discharging foreman and the OOWs, and ensure that it is understood.
- ☐ Give the OOWs additional written instructions regarding the discharging, if the circumstances require it.
- ☐ Liaise with discharging foreman regarding stevedores' damage, work of trimmers, and possible causes of delay.
- ☐ Conduct ship's draft survey or undertake draft survey with an independent surveyor, when appointed.
- ☐ Monitor the commencement of discharging and act promptly to deal with any problems.
- ☐ Use 'informal' draft surveys to monitor the tonnages discharged from time to time during the discharge. Figures are often provided by the stevedores at change of shift so drafts should be taken at these times to allow comparison of ship's and shore figures.
- ☐ Supervise the trimming of holds to ensure that they are properly cleaned by trimmers, and minimum work is left for crew.
- ☐ Ensure that appropriate matters receive attention when particular cargoes are discharged.
- ☐ Provide verbal warning, quickly followed by written notice, to stevedores when the ship or the cargo is damaged.
- ☐ Ensure that the ship is properly secured for sea.
- ☐ Ensure that safe procedures are followed at all times.

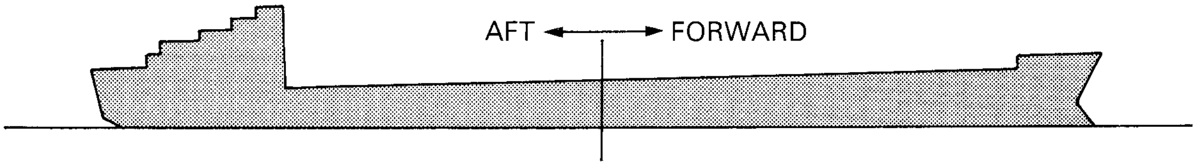
AREAS PRESENTED TO THE WIND

LADEN BULK CARRIER



The area at the stern is much larger than the area in the fore part of the ship

BULK CARRIER IN BALLAST



The effect of the shallow forward draft is to make the forward and after areas approximately equal to one another.

FIG 17.1

CHAPTER 17

THE BALLAST VOYAGE

General remarks, departure from the discharging port, choice of route, routine tasks, conduct of the voyage in rough weather, reporting before arrival at the loading port, partial deballasting before berthing

THE BALLAST VOYAGE is one which takes a vessel without cargo from the discharging port to the next loading port. During such a voyage the vessel will be ballasted to light or heavy ballast draft depending upon the distance between ports, the draft and trim required and the weather anticipated. It may be necessary to change ballast during the voyage in order to reach the loading port with ballast which contains no unwelcome marine life. (Ballast management is discussed in Chapter 7.)

The empty holds may have to be cleaned (a process described in Chapter 5) or if a repeat cargo is to be carried this may not be required. This is a matter on which clear orders are essential. It is reasonable to assume that the holds must be cleaned unless orders have been received to say that they are not to be cleaned. Such orders are most likely when the ship is time chartered for a number of voyages carrying a single commodity. If the master considers that cleaning is unnecessary for any reason, he will be well advised to obtain confirmation from the charterers for the next voyage before he leaves the holds uncleaned. In any event it will be necessary during the voyage to make sure that the ship and her equipment are well maintained, in good working order, ready for the next cargo. (Chapter 6 contains a description of the necessary processes, whilst Chapter 9 describes the need to inspect bilges, void spaces and chain lockers towards the end of the ballast voyage and to ensure that they are all empty when the loading port is reached.)

If there is time during the ballast voyage and if weather permits, it may be possible to carry out maintenance work in the cargo holds. There may be opportunity to paint in the holds, too, provided that painting is not prohibited by the charterparty. It is also necessary to ensure that the paint has a compliance certificate (Appendix 14.29) if foodstuffs are to be carried, and that fresh paintwork will not harm any other intended cargo.

Departure from the discharging port

A ship on a long ballast voyage has a very different timetable to one which is only 12 or 24 hours away from the loading port. In both cases the essentials must be done and that means that the holds must be made ready for the next cargo. In the case of the longer voyage, the work can be done when the weather is favourable during the normal working day and there will be time for additional maintenance work. When time is short, it is sometimes necessary to work around the clock to have holds ready when required.

When a ship leaves in ballast from the discharging port her condition is different in several respects from that of a ship leaving a loading port. The holds are empty except for any ballast holds which may be filled with water ballast. The ship in ballast has a smaller draft, a greater freeboard and, usually, a larger stern trim. She will normally have substantial positive stability in contrast to her condition when loaded, when she may be in any condition ranging from very stiff to very tender, depending upon the cargo carried.

Leaving the discharging port, the ship is often very dirty, with cargo residues widely spread on deck and cargo dust covering decks and superstructures. If hold cleaning is in progress the holds may be open or partly open. If closed, they may not be battened down if the sea is calm and the weather fair. Holds should always be battened down at the end of the working day and thereafter holds should only be unbattened when required for working purposes.

Hazards associated with hold cleaning: The hold cleaning process presents two hazards. Firstly, if hatches are not fully secured and the ship pitches, rolls or heels as a result of meeting swell or a sharp alteration of course, the hatch covers may be disturbed with disastrous consequences. Covers have on occasion been lost overboard or dropped into the hold as a result of being inadequately secured: they must always be properly secured. When it is necessary to open or close hatches the ship should always be put on the heading on which she is steadiest.

The second hazard is the risk of flooding of holds if the weather becomes bad whilst decks and hatches are not secured. A ship in ballast is unlikely to ship quantities of heavy green seas over the decks and hatches, but any flooding should be avoided by always securing hatches, access hatches and ventilators at the end of the working day and when adverse weather is expected.

Choice of route for the ballast voyage

Much of what is written in Chapter 14 regarding choice of route for the loaded voyage applies to the ballast voyage, too, but there are some important differences. If holds have to be washed the route must take the vessel through waters where the discharge of hold washings are not prohibited, though this is not normally a problem on deep-sea voyages. If ballast water has to be changed 'in clear tropical waters' the route must be considered to see whether such an opportunity can reasonably be arranged.

A bulk carrier in ballast will be less likely to suffer heavy weather damage on deck and will have no cargo to break adrift if she rolls heavily. She will, however, be more likely to pound and to suffer from propeller racing when she pitches in a head swell.

The provision of ship routeing services is less common for ships in ballast than for loaded bulkers. This is because ships in ballast are often not on charter and voyage charterers have no interest in their performance at such times. Time charterers, on the other hand, are always interested in the ship's economic performance and may want to use ship routeing services for ballast voyages. Ships on ballast voyages can sometimes gain significant benefits from routeing services and the charterers may decide to employ ship routeing services. If the ship is not on charter the master should obtain authority from his owners to use them when some or all the conditions favouring routeing (as listed in Chapter 15) are met.

Routine tasks

The firstjob when leaving port will be, as always, the securing of the mooring ropes on their reels or if not on reels then below decks. Alternatively, on a short ballast passage ropes not on reels may be left lashed on deck provided that fair weather is expected. Anchors will be secured when clear of the port and of shallow water, and spurling pipes will be sealed.

Washing the ship down to remove cargo dust is a necessary process, but washing with sea water, although the normal practice on most ships, is likely to encourage rust. Where possible other options are to be preferred. For example, the accommodation block can be washed down using a portable high-pressure washing machine and fresh water from a peak tank or from the swimming pool if it has been possible to load fresh water there for this purpose at reasonable cost. Fresh water drawn from the northern Baltic or from the Panama Canal is equally useful for this purpose.

Most modern bulk carriers are able to produce more fresh water than they need at sea and the surplus is sufficient to serve them whilst in port, provided that the sea voyages are long and the port stays are short. However, this does not leave much surplus fresh water for washing decks, superstructure and holds. In the circumstances even a heavy downpour of rain is welcome!

Soundings of all compartments, including bilges and ballast tanks, voids and cofferdams, should be taken daily as they are when the ship is loaded. This helps to identify leaking ballast tanks and provides a check on the reliability of the bilge soundings. If the sounding in a ballast tank is becoming smaller (or the ullage is increasing) the reason must be found. If a hold bilge inspection has shown 20 cm of water the sounding book should show a similar figure. Any unexpected readings should be promptly examined.

The decks should be inspected daily in fair and in rough weather, following procedures to ensure that all deck openings are secured at the end of the working day and before the onset of rough weather. (These procedures have been described in Chapter 15.)

Conduct of the ballast voyage in rough weather

Condition of a bulker in ballast: A conventional bulk carrier in ballast will be stiff, but not as stiff as a bulker loaded with a cargo of steel products. At her ballast draft she will have a substantial freeboard, so that her decks will normally be fairly dry and she will ship less spray than does a laden bulker.

A bulker in ballast presents a large area to a wind on the beam. The area is usually roughly balanced about amidships, as the area presented by the accommodation and hull aft is likely to be equalled by the larger hull area forward, which results from the shallower forward draft (Fig. 17.1). As a consequence a bulk carrier in ballast when lying stopped in the water is likely to lie approximately beam-on to the wind.

Pounding and propeller racing: The conduct of a loaded bulk carrier in rough weather was discussed in Chapter 15 and much of what was written there is equally true for the ballast voyage. There are, however, some differences which need to be emphasised.

Because of her shallow draft the forefoot of a bulk carrier in ballast will emerge completely from the water when she pitches. When the underside of the forefoot (the ship's bottom beneath the forepeak and No.1 hold) crashes down on the surface of the water the process is known as pounding. Pounding can cause serious damage to the shell plating, which appears as dishing of the plating between the double-bottom floors. It is likely that pounding also causes more remote damage in the ship girder. Pounding should be avoided as far as possible. Structural features which overhang in the bow area, such as anchor pods and deck edges extended to accommodate trackways for deck cranes, will also pound when the bows plunge into the swell.

As the swell increases and the vessel begins to pitch the likelihood of pounding increases. Aboard a small bulker the shock and vibration of pounding can be felt throughout the length of the ship and it is a routine matter, though an important one, to reduce speed and/or course to stop the pounding.

Aboard larger vessels, such as Panamax and Cape-sized bulkers, the forefoot is a long way away from the bridge and accommodation and the pounding is more difficult to detect in those positions, although unmistakable to anyone positioned forward. A few large bulkers are now fitted with hull stress monitors (described in Chapter 8) and these will give warning when the vessel is pounding excessively. In vessels without hull stress monitors it is necessary to remember the danger of pounding and the damage which it can do, and to reduce speed when the vessel starts to pitch heavily even if pounding cannot be felt on the bridge.

Whilst at ballast draft the uppermost tip of the propeller will normally be close to the surface when the ship is at rest. When the ship pitches, part of the propeller will emerge from the water and, meeting reduced resistance, the propeller will race and the main engine governor will cut in and temporarily reduce the speed of the engine. When this starts to occur it provides further evidence that the engine speed should be reduced, or course should be altered to reduce the pitching, and thereby to reduce the pounding and racing of the propeller.

Both pounding and propeller racing become worse when the ship's draft is less. This emphasises the importance of having the vessel fully ballasted to heavy ballast condition when adverse swell or weather is expected.

Meeting adverse weather: Chapter 15 offers detailed advice for loaded bulkers when meeting adverse weather and that advice is equally valid for bulk carriers in ballast. If the weather causes a speed reduction of 25 per cent with constant engine settings, the engine RPMs should be substantially reduced to avoid damage from forcing the ship into the weather. Prolonged violent rolling can damage the side shell plating and framing of a bulk carrier, and violent pitching or corkscrewing is dangerous and should be avoided by alteration of course and/or speed.

When a vessel is moving violently, ballast water in part-filled ballast tanks will slosh, a process that can damage the ship's structure. When rough weather is anticipated ballast tanks, and in particular ballast holds, must not be left in any condition other than 100 per cent full. When rough weather persists ballast tanks should be topped up from time to time to replace ballast which has slopped out of airpipes and ventilators. This precaution, too, is particularly important in the case of ballast holds.

Heaving-to: The description of heaving-to contained in Chapter 15 for loaded bulkers applies equally to bulkers in ballast, with one difference. A loaded bulker naturally lies head to wind as a result of the accommodation block which acts as a sail, whilst a bulker in ballast is more likely to lie naturally beam-on to the wind for reasons discussed above. Despite this it is usually possible to use the engine at slow speed and the rudder to heave-to with the wind about 45 degrees on the bow.

Turning through the trough: Turning through the trough (as described in Chapter 15 for loaded bulkers) applies also to bulkers in ballast. Since ballasted bulkers lie naturally beam-on to the wind they will turn easily until they are lying in the trough, but will be slower to continue the turn, regardless of whether they are being turned into or away from the wind and swell.

Reporting

During a ballast voyage the master will be required by owners and by charterers if on charter to submit routine position reports and ETA messages to various parties at specified intervals. His voyage orders may also required him to report when hold cleaning has been completed.

Before arrival at the loading port

A day or two before arriving at the loading port, at the latest moment which allows sufficient time to put right any problems which are found, all holds should be reinspected to ensure that they remain ready for the loading of cargo. Such an inspection may find puddles of water which have formed on the tanktop from condensation or other sources, or undetected cargo residues which have fallen from places high in the hold.

Void spaces, bilges, chain lockers and any other spaces where unnecessary water is being carried should be pumped out to ensure that the ship is carrying no additional weights. Where the next cargo is one which can suffer from water damage the opportunity should be taken, where possible, to test the watertightness of the hatch covers (see Chapter 4) and to record the result in the deck log book. If leakage is found, the fault should be corrected and the covers retested so that a satisfactory result can be logged.

Partial deballasting before berthing

When the loading terminal is able to load at a very high speed, the terminal operators may want the ship to discharge part of the ballast before berthing to allow a faster loading rate. When the ship is unable to deballast at a satisfactory rate, the master may want the ship to discharge part of the ballast before berthing to enable the ship to comply with the required loading rate.

In both cases this want must be balanced against the possible difficulties of manoeuvring into the berth at light draft and the available air draft must be considered. (These matters are fully considered in Chapter 7.) Full account must also be taken of any pilotage or port regulations regarding the draft, trim and propeller immersion which are acceptable to the authorities.

Arrival in the loading berth

Chapter 11 discusses the arrival at the loading berth and recommends that the vessel should berth with hatches open over the first hold to be loaded, or all hatches open, when weather and sea conditions allow.

CHECKLIST-Routine procedures for the ballast voyage

- ☐ Have mooring lines all secured well before the open sea is reached. Secure anchors when deep water and open seas are reached.
- ☐ Decide what cleaning the holds require and do it.
- ☐ Close and batten down hatches except for those where work is proceeding.
- ☐ If judged safe to do so, leave open holds which are being cleaned. When open, as when closed, hatch panels must be secured to prevent movement.
- ☐ Take light or heavy ballast according to assessment of weather expected on voyage.
- ☐ Wash down decks and superstructure.
- ☐ Take a full set of soundings every day and study them for any unexplained increase or reduction in sounding.
- ☐ Investigate promptly any unexplained changes in soundings.
- ☐ Change ballast whilst in mid-ocean if so required for discharge port and keep a full record of the process in the deck log book.
- ☐ Change from light to heavy ballast or vice versa during voyage if weather conditions warrant it.
- ☐ Inspect the decks daily and ensure that storerooms, hatch accesses, hatch covers and manhole covers are secure at the end of the day and before the onset of bad weather.
- ☐ In bad weather inspect the decks daily, taking all necessary precautions to ensure the inspection is safe and thorough.
- ☐ When the ship is slowed by bad weather reduce the engine speed or alter course.
- ☐ Follow safe procedures for heaving-to with the weather on the bow or on the quarter, and for turning through the trough.
- ☐ Make routine position and ETA reports as required.
- ☐ Ensure that all the ship's systems (ventilation, airpipes, hold bilges, sounding and hold temperature systems, deck and hold lighting, fire smothering systems, hatch coaming drains, deck machinery, derricks, cranes and grabs) are in good working order.
- ☐ Before arrival at the loading port ensure that the holds and bilge wells remain clean and dry.
- ☐ Before arrival at the loading port ensure that bilges, void spaces, chain lockers and all other compartments which should be empty are empty.
- ☐ Test hatch covers for leakage and log the result.
- ☐ Before berthing at the loading port discharge heavy ballast (e.g., contents of ballast holds) on occasions when it is safe and desirable to do so.
- ☐ Clear anchors and prepare ropes for berthing.
- ☐ Arrive in the loading berth with the first hold or all holds open ready for loading, as may be required by the charterparty.

CHAPTER 18

SPECIAL TYPES OF BULK CARRIERS

Operational characteristics of self unloaders, mini-bulkers, forest product ships, log carriers, retractable tweendeck vessels, vessels with Munck cranes and combination carriers

Self-unloaders

SELF-UNLOADING bulk carriers which discharge cargo by means of ship-mounted conveyor belts have been known on the Great Lakes for many years, but only moved into the international trades in the 1980s. In European waters one of the pioneeering shipowners of this trade has been A/S Kristian Jebsens Rederi of Bergen with ships such as the 10,000 tonnes deadweight *Telnes,* built in 1982 and operated by Jebsens' UK subsidiary. (Fig. 18.1)

After an initial period during which the vessel successfully carried a wide range of traditional cargoes between North Sea ports she has been employed mainly in the coal trade, delivering coal to power stations on the Thames estuary from Amsterdam, Rotterdam, Zeebrugge and the North East Coast of England. In this trade she will often carry three cargoes a week with loading, loaded passage, discharge and ballast passage each taking about 12 hours. The *Telnes* averages 100 voyages, or 200 port visits, a year.

The trade is one in which lack of experience on the part of the ships' personnel can lead to considerable delays, since failure of the ship's discharging equipment results in a complete cessation of work with litde opportunity for discharge by alternative means.

Self-unloaders have a capital cost which is 20-35 per cent higher than conventional bulkers and provide less space for cargo than do conventional ships of the same size. These disadvantages can be more than balanced by their reduced port time for discharging, so they are most profitable when employed in shuttle services with very frequent port calls.

Ship's particulars: The *Telnes* is a four-hold self-unloading bulk carrier with bridge, accommodation and machinery spaces located aft. She was built by Eleven Mek Verksted A/S of Ulsteinvik, Norway, in 1982, classed by DnV with the notation 1A1 ICE 1A, EO, and is registered in London. Her principal dimensions are length overall 118 metres, breadth moulded 20.5 metres, depth moulded 11 metres and loaded summer draft 8.466 metres with a corresponding deadweight of 10,110 metric tonnes. Her gross tonnage is 6,792 rt and net tonnage 4,249 rt, whilst her trial speed was 14.0 knots.

The four holds have a 'W shaped cross-section, with the gates for discharge of the cargo being situated at the two base points of the 'W. Interconnected upper and lower wing tanks for ballast occupy the spaces created by the self-trimming shape of the holds, and double bottom ballast tanks are also fitted.

When discharging, the cargo is gravity-fed from the vessel's holds through a number of hydraulically-operated hopper gates on to conveyor belts which run forward beneath the holds. It is raised from hold level to boom height by a vertical belt, from where it joins the boom conveyor belt to be discharged. The boom can unload cargo at any point up to 30 m from the ship's side and up to 15 m above the main deck.

Further details of the vessel and her equipment are contained in Appendix 17.1, whilst the cargo discharging equipment is described in more detail later in these notes.

Loading: Preplanning of the loading is done without the aid of a loading calculator: none is provided since the calculations are elementary. For a normal coal cargo the ship will be filled before she is loaded to her marks, so no decisions as to the distribution of the cargo are required. All holds must be filled. If a denser cargo is to be carried the cargo distribution is planned to ensure a satisfactory trim, and calculations will be routine ones using stability formulae and trimming tables.

The loading sequence, hold by hold, is normally 3, 1, 4, 2, with a final trimming pour of about 400 tonnes in No. 4, aft. This sequence ensures that a stern trim can be maintained throughout loading, thus assisting deballasting. Loading is by shore-based shiploader or grabs.

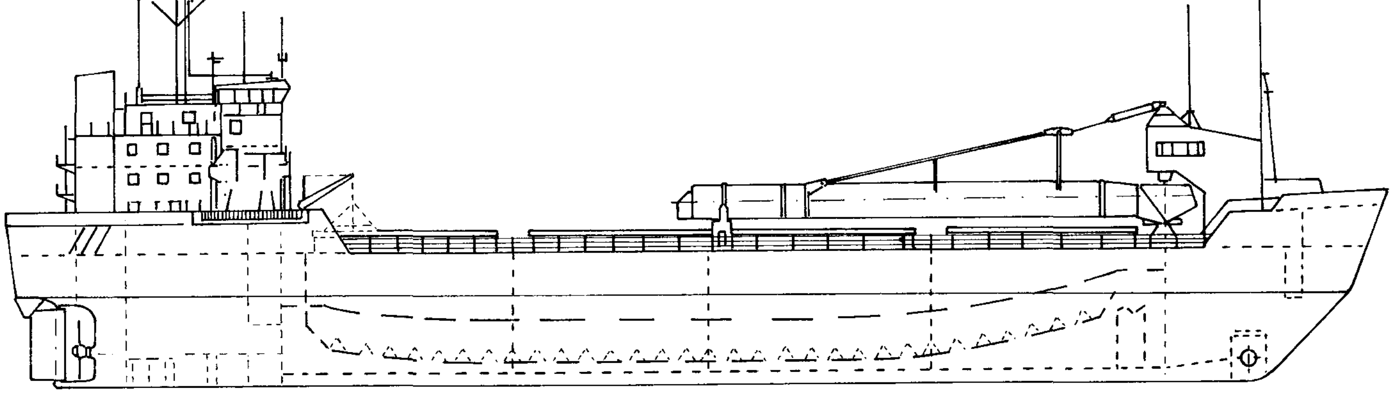
Before loading the forward hold the boom, which has a length of 40 m and a maximum outreach of 30 m, must be swung out to the offshore side at right angles. Since this would cause a substantial list, ballast must be discharged from an offshore tank to keep the ship upright, this process taking about 20 minutes. When swung out the boom end must be marked with a flashing orange safety light. The purpose of the trimming pour at the completion of loading is to bring the ship upright after the boom has been swung back to its stowage position amidships. Subject to this requirement as much as possible of the remaining space will be filled. The stowed boom is located over Nos. 1-3 holds, but is clear of No.4.

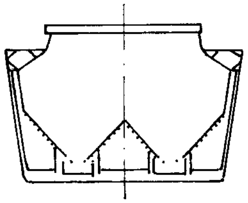
Deballasting takes place concurrently with loading and is arranged by the duty officer-normally the chief mate-from the control room where controls for the ballast valves and pumps are placed.

Steel debris in the cargo loaded, originating from rail wagons or previous ships to carry the cargo, is likely to cause enormous damage to the ship's discharging gear. The system can accept items no larger than a football, but sharp edges are likely to cause damage. Such items of debris cannot always be seen in a bulk cargo but where they are noticed every effort must be made to prevent them from being loaded.

Loaded voyage: Sometime before commencement of discharge the chief mate will inspect the discharging gear to ensure that all appears in good order. If planning a discharge in an unfamiliar berth the chief mate needs to know whether there are any weight restrictions. There may, for example, be maximum permitted loadings for a quay where stockpiling is carried out. Discharge is likely to be to hopper feeding another conveyor belt or to stockpile or barge.

SELFUNLOADING BULK CARRIER





Principal Dimensions

Length Overall	117.9	metres
Breadth Moulded	20.5	metres
Depth Moulded	11.0	metres
Summer Draft	8.5	metres
Deadweight on Summer Draft	10,110	tonnes
Service Speed	14.0	knots

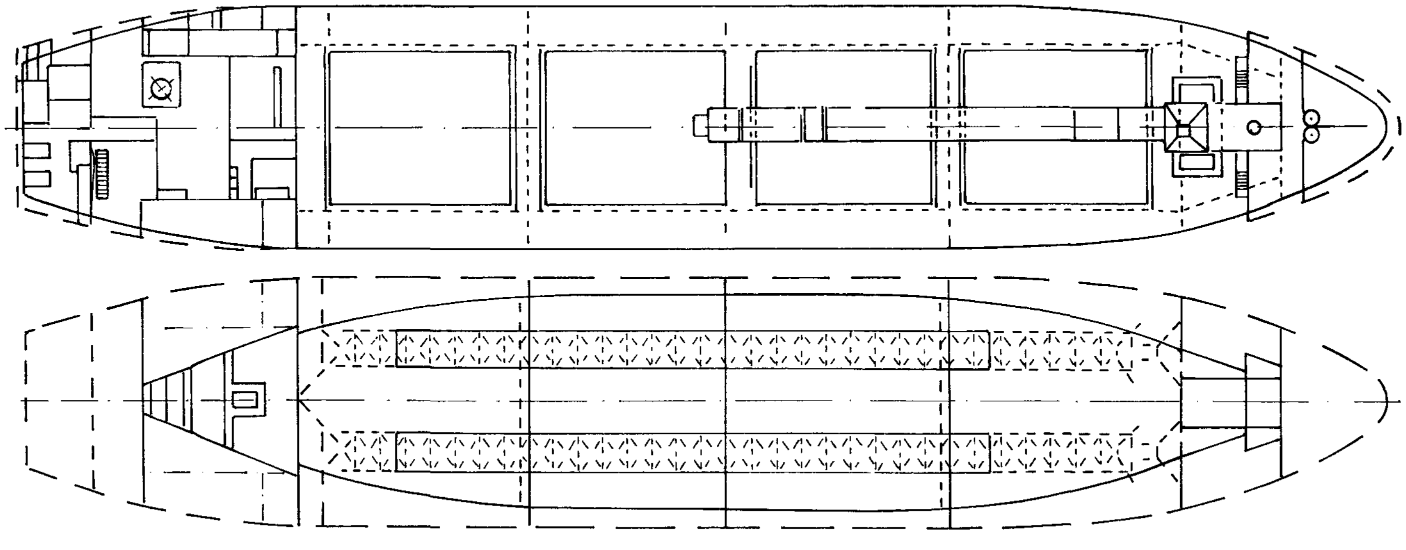


FIG 18.1

Discharging: A cargo hold tunnel runs along the ship's centreline with, on each side, a main cargo conveyor belt positioned below the gates in the hold bottoms. A selected pair of gates, one port and one starboard, is partly opened to release a flow of cargo on to the main belts which carry the cargo to the fore end of the ship. Here transfer belts bring the cargo amidships to the loop belts situated in the 'cathedral', so-called because of its height. The cargo is compressed between the inner and outer loop belts which raise it vertically to the start of the boom conveyor belt. From the end of the boom conveyor belt, enclosed within the boom, the cargo is discharged ashore.

Communications between ship and shore are usually by means of VHF handsets provided by the shore installation. Alternatively portable telephones may be used. Shore installations accepting cargo direct through a hopper on to a conveyor belt may have a siren to indicate when the belt has stopped.

All discharging operations including positioning of the boom, commencement and stopping of cargo, and rate of discharge are controlled from the ship's cargo control room. Three closed-circuit television cameras are strategically sited in positions in the tunnel, the cathedral and at the boom end to allow the operator in the cargo control room to monitor the flow of cargo. A wandering lead can be used by an officer on deck or ashore to position the boom for discharge into barges.

Operation of the gates at the bottom of the holds to govern the flow of cargo on to the belts requires skill and experience, particularly when cargoes are not free flowing. If there is a mechanical failure of the belts, or if cargo is allowed to flow out too fast, it will jam and overflow the belts. When this happens tonnes of cargo must be shovelled out of confined spaces in the tunnel by hand to free the belts and allow a resumption of discharge. Cargo which overflows in this way will generally be shovelled back on to the belts and discharged.

Control of the flow of cargo is achieved by the amount the gates are opened. For dry coal or for grain the gates are only cracked open. The only indication the operator has of how much cargo is dropping on to the belts is given by the load on the belt motors. If the cargo is sticky, for example moist coal, it may be that initially no cargo drops at all. The flow of cargo can be assisted by operation of the vibrators which are situated next to each gate. These vibrators, also operated from the cargo control room, are in the form of eccentric weights which when activated shake the framework to which the hold plating near the gates is attached.

If cargo starts to overflow a belt at a time when several pairs of gates are open, the operator has no sure way of knowing which pair of gates is releasing too much cargo. A quick-close button permits him to close all gates instantaneously, after which he can gradually reopen the gates in turn. When discharge is interrupted, the belts should if possible be emptied before they are stopped, since it can be very difficult to start the belts when they are loaded. Maximum tonnage likely to be on the belts is 50 tonnes when discharging at maximum rate.

During discharge the ship must be kept even keel as far as possible, with a maximum acceptable trim of 2 metres by the stern, since a greater trim puts an excessive load on the belt motors. If it is necessary to restart the belts when they are fully loaded it may be necessary to trim the vessel by the head to assist the forward momentum of the cargo on the belts.

List must also be kept to a minimum, with a maximum of no more than 1 degree. A list causes the belts to 'wander towards the list', causing scuffing of the belt edges, which reduces its life. This is expensive in replacement material and in repair time. List and trim are monitored in the control room by means of sensitive inclinometers consisting of weighted 1 metre lengths of line attached to the transverse and fore-aft bulkheads.

Holds may be discharged or part discharged in any convenient sequence calculated to preserve the desired trim. One favoured sequence is: (i) empty No.2 hold; (ii) alternate between Nos.l and 4 holds until they are empty, keeping trim below 2 m; (iii) complete by discharging No.3 hold. Discharging rates of 1,800 tonnes/hour can be achieved if coal is very dry, and a rate of 1,000 tonnes/hour can comfortably be maintained throughout discharge with most coal cargoes.

On deck and ashore the discharging process is not a dusty one, because the discharging belt is inside the boom. The holds can be kept covered throughout discharge, although the lids must be raised to allow air to enter and they are normally opened for convenient monitoring of progress. When the ship is on a regular coal run, holds are not cleaned between cargoes and the ship sails with some cargo residues between the frames on the transverse bulkheads. The ship's constant, which includes cargo residues and sediment in the ballast tanks, is about 240 metric tonnes.

Discharge can be controlled by a computer program which can be instructed to maintain a stipulated rate of discharge, although with some cargoes manual operation is preferred as it offers more control. Ship's staff find that the program is unable to recognise instances in which the cargo is sticking and will open the gates wider and wider until a large volume of cargo is suddenly dumped on the belts. This can be prevented by setting a maximum permitted opening percentage for the gates. Ballasting is carried out from the control room whilst the cargo is discharged, with care to ensure that list and trim are kept at a minimum.

Two sailors remain on duty throughout discharge. In addition to normal mooring and gangway watch they are responsible for making an inspection in the cargo tunnel at hourly intervals. Any belt roller which is seen to be not turning is freed by tapping or, if that fails, is noted for changing at the first opportunity. A normal 650 mm roller takes about 10 minutes to change. The sailors look out for any spillages of cargo, which must not be allowed to build up under the belts, and they shovel any overflows of cargo back onto the belts or if this is not immediately possible clear of the working area.

Whilst discharging is taking place the tunnel becomes dusty. The tunnel is ventilated by fans and to ensure that it remains well ventilated it is only possible to engage the cargo breaker and commence discharge when the fans have been running for 15 minutes. On completion of discharge the boom is swung inboard and the ship is brought upright with ballast, one tank

DISTRIBUTION OF CARGO IN MINI-BULKER

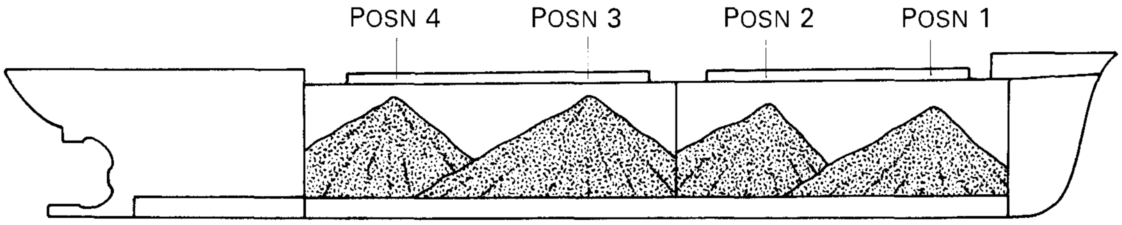
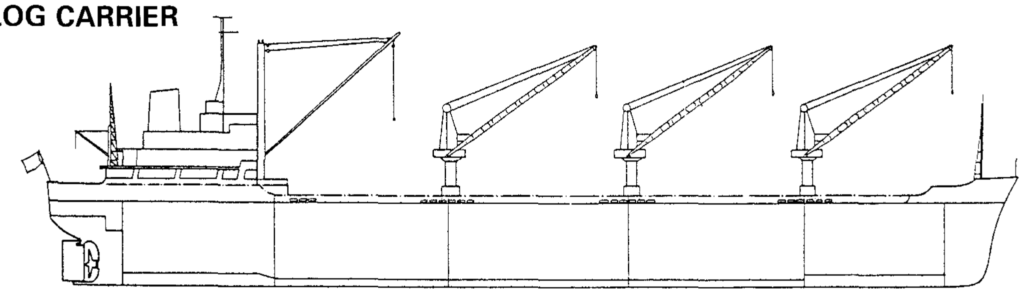
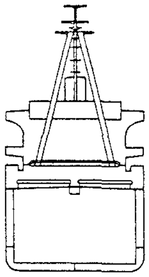


FIG 18.2

LOG CARRIER





Principal Dimensions

Length Overall	148.0	metres
Breadth Moulded	21.0	metres
Depth Moulded	12.0	metres
Summer Draft	9.15	metres
Deadweight on Summer Draft	16,000	tonnes
Service Speed	14.0	knots

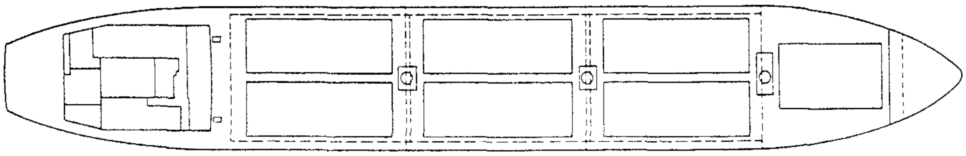


FIG 18.3

having been left slack for this purpose.

Belt system: Power to the seven belts which in combination form the discharging system is provided in a variety of ways. The two main cargo belts and the two transfer belts are driven by 440v AC electric motors through Dodge reducers fitted onto the driving rollers. The inner loop belt main drive wheel is driven by two electric motors through two fluid clutches into two Hansen reducers, one each side of the loop casing. The outer loop belt is driven by the inner loop belt by friction. The main boom belt, like the inner loop belt, is driven by an electric motor through a fluid clutch into a Hansen reducer.

The tension in each of the belts is adjustable, and belt tension is an important factor in efficient discharge. Too much tension in the cargo belts will reduce the concavity of their cross-section, and their ability to contain cargo, thus squeezing cargo out of the system. Too little tension will permit the belts to wander. Tension in the main cargo belts is adjusted by adding or removing tensioning weights, whilst screw tensioners are used to adjust tension in the transfer belts and the main boom belt. The tension of the loop belts is adjusted with hydraulic rams, with typical pressures for coal being 1,400 psi for the inner loop belt and 1,250 psi for the outer loop belt. The belts are automatically stopped if pressure is lost. Suitable tensions for the discharge of a particular cargo have to be found by trial and error, with finer grained cargoes requiring lower belt tensions.

Bins are situated between the transfer belts and the loop belts and between the loop belts and the main boom belt. The bins act as hoppers which feed cargo on to the next belt in the system. Pressure pads fitted in the bins will detect any build-up of cargo and will automatically close the cargo gates to stop discharge. In the bins at belt ends, defector plates are installed to guide the cargo down on to the centre of the next belt. These have to be adjusted for a change of cargo and may seize up if not operated from time to time. A trip line runs the length of the tunnel and can be used to stop the belts instantly in the event of emergency.

Ballast voyage: Washing of the tunnel is carried out every voyage or at the very least every second voyage. The washing is done with sea water and the objectives are to ensure that the cargo gates are clean and free of any material which might clog them, to wash away any cargo spillage from the tunnel, and to remove the dust. Washing below the gates is done with the gates closed and is difficult, as the space is restricted. The water and all the residues are removed from the bilges by eductors and discharged into the sea when regulations permit. Washing the tunnel normally takes about two hours. Washing the tunnel with sea water encourages corrosion, which may become a problem as this type of ship becomes older, so frequent fresh water rinsing must be carried out.

The cargo holds are not washed if the next cargo is to be similar to the previous one. If holds have to be washed prior to carriage of a different cargo they are washed with seawater from handheld hoses with the gates open, and water draining into the tunnel for discharge by the tunnel eductors. If necessary the seawater wash will be followed by a fresh water rinse.

If a very fine grained cargo, such as nefelin syenitt, is to be carried, the hold gates must be lined with polythene sheeting or tarred paper before commencement of loading to prevent cargo from leaking through the closed gates during the loaded passage. This lining will drop through the gates when discharge commences and be discharged with the cargo.

Maintenance: All the deck machinery, including all the discharging gear, is thoroughly greased on a continuous cycle once every six weeks. The full greasing programme takes about four days, with half a day spent on deck fittings including hatch covers and three and a half days spent on the cargo gear. Every large belt roller is provided with a grease nipple at each bearing. The outer nipple is difficult to reach in the restricted space outboard of the belt. Each gate has four greasing points which are not easily accessible.

The ship has the capability to make small repairs to the belts using special clips, but the belts are vulcanised and cannot be permanently repaired by ship's staff.

The cargo belts are connected to the motors by drive belts. If the system is overloaded or if the drive belt is worn, the drive belt will part. It is routine to look behind the guard frequently and to renew the drive belt when it is seen to be worn or damaged.

The main and transfer belts are fitted with skirting at the sides to prevent cargo from falling off the belts, and this skirting must be renewed as it becomes worn. The belts are also fitted with scraper plates to remove residues from the return portion and they, too, require renewal when they are worn out. The main rollers at the ends of each belt are very heavy and difficult to change, chain blocks being required for this process.

The cargo gates are electro-hydraulically controlled. Repairs to the hydraulic pipework, a category of work which becomes larger as a ship grows older, are done by available ship's staff drawn from deck and engine departments.

Cargoes carried: The *Telnes* has successfully carried coal, gypsum, limestone, magnetite, ilmenite, petcoke, chalk, barley, oats, wheat, pyrites, olivin, coke, quartz, salt, stone, iron ore pellets, iron ore fines, cement clinker and nefelin syenitt. Alumina, however, was found to be too fine and presented serious problems with the belt tensions in use at that time.

At the other extreme, any cargo which was excessively sticky would be impossible to discharge with ship's gear and would have to be discharged by grab. Such cargoes would not be carried. Cargo which is spout-loaded will generally discharge more easily than cargo loaded by grab, since the latter process tends to compact the cargo.

Mini-bulkers

Bulk carriers of up to about 10,000 metric tonnes deadweight are often called mini-bulkers. Whilst some vessels of this size are engaged in worldwide trading and many are equipped so to do, their main trades are the European short-sea trades. In European waters several thousand mini-bulkers are employed primarily in trades with a draft limitation of about 8 metres or where the requirement is for comparatively small tonnages of cargo. Mini-bulkers are more likely to make long passages upriver to small inland berths, and can be expected to take the ground more often in berths where this is intended than do larger bulk carriers.

Ship types: Mini-bulkers (Fig. 1.35) are normally one- or two-hold vessels of up to 100 metres in length, with large hatch openings and powered steel hatch covers. The trend has been towards vessels of double skinned construction with box holds. Some are fitted with cranes or swinging derricks for cargo loading and discharge, whilst others are gearless.

Intensive trading pattern: The pattern of trade for these vessels is intensive, since a full cargo can in many ports be loaded in 6-12 hours, and will rarely take more than a day, whilst discharge is unlikely to take more than two days unless a weekend is included. Because the sea passages are also short, experienced ship operators are able to plan tight schedules, trying to ensure that ships are at sea over the weekend. A schedule of 50 voyages a year with more than 100 ports visited is normal and will be composed of hectic spells in which three or four ports are visited in a week, interspersed with the occasional longer voyage, often in bad weather, and occasional quiet periods at anchor awaiting a berth.

Communications: Detailed voyage orders will normally be received in printed form by telex or facsimile transmission to the ship or her agents, but most subsequent communications are likely to be by telephone, either via VHP or by mobile telephone.

Ship handling and pilotage: Mini-bulkers require tugs very rarely. It is unusual for such vessels to have cp propellers or bow thrusters, but the traditional use of engines through a clutched ahead/astern gearbox, rudder, anchor and mooring ropes is normally sufficient to allow them to manoeuvre into and out of their berths. Where pilotage is not compulstory the master will often elect to do his own pilotage, particularly when he is familiar with the berth.

Whilst mini-bulkers are manoeuvrable ships and are usually well handled, the fact that they berth so many times in the course of a year means that they are at risk more often and that they are likely to suffer more contact damage than larger bulk carriers. Some berths are less well suited to mini-bulkers than others. Amongst the most challenging for a 90 metre ship is a jetty with a face of 7 metres, and with a loading structure mounted on top of it! Mooring lines are secured to distant dolphins, or to bollards or even trees on the shore.

Cargoes: Cargoes carried in mini-bulkers include almost every commodity which enters world trade in bulk. Grain including wheat, barley, oats and soya beans is an important trade, as is the transportation of chemical fertilizers. Coal, coke and petcoke is extensively shipped and transhipped in mini-bulkers, as is steel in the form of coils and slabs. Other cargoes widely carried are forest products, quartz, salt, aggregate, ferrous scrap, clay, minerals and sands.

Hold preparation: A feature of the efficient operation of mini-bulkers is the regular occurrence of backloading, whereby a new cargo is loaded in the port or area where the previous cargo was discharged. In European waters this is particularly likely in large and busy ports such as Rotterdam/Europort, Hamburg and Antwerp. This puts particular pressure upon the ship's personnel because of the requirement to prepare the holds for a new cargo without benefit of the ballast passage in which such work is normally done.

It will always be necessary to ensure that the sounding pipes and bilges are clean and that the bilges have been covered and burlapped before the new cargo is loaded. Usually it will also be necessary to wash the holds. In many ports and berths this is possible, particularly when the cargo residues have no unpleasant characteristics. Many bulk cargoes are inoffensive. Cargoes residues which will float, like coke or soya beans, or which will leave oily traces, like petcoke, will be unwelcome in any port and holds containing such residues cannot be washed in port. The preparation of a mini-bulker's holds by washing can normally be completed in four-six hours. Holds which have surfaces which are still damp from washing will normally be acceptable in these trades, except for sensitive cargoes such as grain and fertilizer. However, when holds remain damp all puddles on the tank top must be mopped up.

Loading calculations: Stability and loading calculations on mini-bulkers are simplified by the fact that no stress calculations are required. In other respects the calculations are similar to those for larger vessels, except that the number of compartments and the number of loading positions is reduced. The constant, or miscellaneous weights allowance, for a 3,000 metric tonnes deadweight vessel is likely to be 30-50 tonnes, and for a 6,000 mt dwt vessel can be expected to be 50-90 tonnes. These figures can be substantially higher if the ballast tanks contain quantities of mud.

Loading: Loading is normally by means of a loading spout through which cargo is poured into the hold. The spout is frequently fixed, or has only limited mobility, so that the ship must be moved back and forwards along the berth to permit loading in the required positions. A typical loading of a closeweight or heavy cargo for a mini-bulker would involve loading cargo in four positions distributed along the length of the ship (Fig. 18.2). The four pours might be taken in positions 3, 1, 4, 2 in sequence, followed by a trimming pour of about 300 mt if the cargo to be lifted is 3,000 mt. This sequence would be planned to ensure that the ship maintained a stern trim throughout loading, for efficient deballasting.

Because of the requirement to position the ship below the loader for each pour it is necessary to warp the ship along the berth to a new loading position four times during the course of loading. This is a process which will normally require a minimum of five men-namely, two at each end of the ship to handle the mooring ropes and one at the loading position to signal when the ship is correctly positioned. The process can be expected to take about 10 minutes provided the crew are prepared and the working conditions are not exceptional.

Loaded voyage: During the loaded voyage a mini-bulker is likely to have a freeboard of no more than 1-2 metres amidships. She will probably be shipping water on the main deck even in the calmest weather, and in any adverse sea and wind she will be taking spray forward. The hold ventilators of most mini-bulkers operating in the European trades are permanently closed and blanked off.

Keeping water out of the holds and the forecastle spaces is a matter which must never be neglected in mini-bulkers in view of their small freeboard. It is essential that the seals for hatches and for watertight doors and ventilators are well maintained and tightly closed when the vessel goes to sea, and that compartments are frequently inspected for damage, wastage and leakage. It is prudent to heave-to and make an inspection of hatch covers, anchors and windlass, and forecastle store at the start and end of each day when encountering severe weather.

High-level bilge alarms are fitted in the forecastle spaces of most mini-bulkers. It is good practice for the officer routinely to test the alarm when he leaves the forecastle head at the commencement of every sea passage. Thereafter, if the alarm sounds an investigation should be undertaken at the first opportunity.

The fact that the vessel is likely to be shipping water on deck during loaded passages means that it is seldom possible to obtain direct soundings of hold bilges or ballast tanks. Where reliable remote sounding gauges are available there is no problem, but on many older mini-bulkers it is likely that no soundings can be obtained during normal and worse-than-normal weather.

Discharging: When discharging it is normal to open all holds and to let the stevedores take cargo from along the length of the ship as convenient and subject to preserving a reasonable trim and keeping the ship upright. It will usually suit stevedores and ship's personnel if discharge of separate holds is finished in sequence, and not simultaneously. If the ship wishes or requires to commence cleaning holds as soon as possible the preferred hold for first completion should be named to the stevedores.

Discharge, in general, is similar to that for larger bulk carriers. Most discharging methods are liable to damage the ship if carelessly used and the holds should be regularly checked for damage during discharge and on completion.

Sediment in ballast tanks: A result of ballasting the ship 50 times a year is that the build-up of sediment or mud in the ballast tanks is likely to be rapid. This increases the ship's deadweight constant and increases the time required for discharge of ballast. It is necessary to look for any opportunity to remove mud from ballast tanks.

Maintenance programmes: Adverse weather conditions consisting of cold, rain, wind, salt spray and darkness all conspire to reduce the amount of maintenance that can be carried out aboard mini-bulkers in the European trades during winter. It is realistic to expect very little maintenance work except essential greasing to be done about the decks from December to February, unless unseasonal weather is met. For this reason it is essential that maintenance and renewal of the ship's safety equipment, hatch covers, deck machinery, cargo gear and paintwork is commenced as soon as the first mild weather is experienced in spring time, and continued with commitment until the autumn is well advanced.

Means of access: Access to a mini-bulker, as to larger bulk carriers, is often difficult. Rise and fall of tide, rapid alteration in draft of the ship and the requirement to shift back and forth along the berth all make it difficult to arrange a good means of access. Difficulties are increased because the jetty is often higher than the deck of a mini-bulker, and the stern with its accommodation ladder may be beyond the end of the jetty. Ships are able to provide gangways (also known as brows) and accommodation ladders. Sometimes in desperation 'plain' ladders of wood or aluminium, or pilot ladders, will be used. Occasionally effective shore gangways are provided, and this is to be welcomed for the improved safety which it offers.

Forest product ships

Forest product ships (Fig. 1.38) are handy-sized geared bulk carriers which are able to carry a range of bulk cargoes but which are particularly well suited to the carriage of woodpulp, sawn timber and newsprint, all cargoes which are relatively light and which can be most easily stowed in rectangular spaces. Such vessels have an open hatch layout in which the entire box-shaped hold is open to the sky when the hatch covers have been opened. This permits units of cargo to be landed directly in the intended stowage position. The designers achieve the box-shaped hold configuration by placing ballast tanks between the hold and the ship's sides.

Ice strengthening: Forest product ships are often ice strengthened, since many producers of these cargoes, such as Canada, Russia and Scandinavia, are located in areas which experience ice in winter. A bulk carrier fully laden with woodpulp or with sawn softwood will not sink to her winter leadline. Because of this the ice strengthening on some ships is only continued up to the anticipated operating draft. If such a ship loads a full closeweight cargo she will be operating at a draft deeper than the ice strengthened band, and effectively becomes a ship without ice strengthening.

Carriage of deck cargo: Another feature which identifies the forest product ship is the provision for carrying deck cargo. To permit the carriage of the maximum volume of timber on deck the ship's cranes, capable of lifting units of 16 tonnes or more, will be mounted on pedestals which carry them clear of any deck cargo and which occupy a minimum of deck space. The decks and hatch covers will have been strengthened to allow the loading of a permitted tonnage on deck. Timber deck cargoes may be retained in position by vertical timber stanchions and the box-shaped steel housings, or sockets, for the stanchions are built into the ship's structure along the line of the ship's side rails (Fig. 1.30). Alternatively, the ship may be fitted with permanent tall vertical steel stanchions or pillars at the sides of the deck.

The IMO *Code of Safe Practice for Ships Carrying Timber Deck Cargoes* provides detail of the regulations governing the stowage, lashing and securing of timber deck cargoes and related matters such as stability and ship handling in heavy weather. It should be studied and followed whenever a timber deck cargo is carried.

When such deck cargoes are carried, it is essential that access to safety devices, sounding pipes, remote controls for valves and closing arrangements for deck houses is maintained. To ensure this the deck will be permanently marked with black/yellow stripes in positions where deck cargo must not be placed.

Lashings for timber deck cargoes may be kept permanently aboard a forest product ship or may be provided with the cargo and landed at the end of the voyage. Each lashing must be independent and will consist of wire rope and/or chain, with a quick release mechanism such as a senhouse slip, connecting shackles and a stretching device such as a turnbuckle or speedlashing. (Speedlashings are turnbuckles which can be tightened by use of an air-powered tool.) They must be in sound condition, well maintained and properly certified according to national regulations. In addition they should be visually examined for defects annually, and moving parts must be kept greased and moving freely at all times.

Problems may arise if the national regulations of the shipowners are different from those of the country in which the cargo is loaded-for example, the Canadians will require each and every item of lashing gear to have a test certificate showing a breaking load, whilst the British consider that lashings including lashing chains only require visual examination and need not be certificated.

View from the navigating bridge: One consequence of raising deck cranes high above the decks is that the view ahead from the bridge may be restricted, particularly if twin cranes are fitted side by side. On sea passages the bridge watchkeeper will have to be prepared to move from side to side of the bridge to ensure that he obtains a good view ahead around the stowed cranes. On river passages in sheltered waters it may be possible to put the jibs of twin cranes vertical and to slew the platform for the twin cranes to a position in which the blind sector of the horizon ahead is reduced. Deck cargo may also restrict the view ahead and where necessary it must be stepped down over the forward hatches.

(Carriage of forest products: Forest product cargoes are described in Chapter 19.)

Log carriers

The log carrier which provided the basis for this section (Fig. 18.3) was a geared bulk carrier with bridge, machinery spaces and accommodation aft, and having four holds of which Nos 2-4 were provided with twin hatches. Her approximate dimensions were 10,300 tons gross, 6,200 tons nett and 16,000 tonnes dwt with overall length 485 ft, beam 70 ft, moulded depth 40 ft and maximum draft 30 ft. The three cranes and one swinging derrick possessed SWLs of 16 tonnes.

Whilst this vessel was engaged principally in the trade between the US/Canadian West Coast and Japan, the operating procedures described are equally valid for smaller two-hold loggers trading in Asian and African waters. These procedures should be read in conjunction with the IMO *Code of Safe Practice for Ships Carrying Timber Deck Cargoes*[18].

Concern has been expressed at the substantial number of log carrier casualties which have continued to occur over many years. Contributory factors are thought to have been inadequate initial stability due to taking of excessive deck cargo, shifting of cargo above and below decks due to poor stowage, and flooding of holds due to structural damage suffered when loading and discharging logs.

Preparation of the vessel: Holds must be swept and free from all debris. Hold bilges must be clean and tested. A portable dewatering pump (sump pump) of capacity sufficient to pump water from holds to deck is useful to deal with flooding if a bilge becomes blocked.

Logs loaded from rafts floated down to the vessel bring on board considerable quantities of water which can lead to hold bilge soundings of several feet. Bilges may need to be pumped several times to remove this water as it has to filter through the logs, and by the time it reaches the bilges it usually contains pieces of bark, weed, mud and other debris. To prevent the bilge strum becoming blocked, the entrance can be stuffed with wire netting (chicken wire) to attempt to filter out the larger pieces of debris.

Any changes to the ballast distribution should be made as soon as practicable, leaving ballast tanks either completely rilled or empty to eliminate free surface effect wherever possible. In any event all ballast movements must be completed before loading the deck cargo. Bunkers should be kept to the minimum number of tanks consistent with operational requirements to reduce the free surface effect.

Any bunkering operations should, if possible, be completed before loading the deck cargo. The sounding of tanks and communicating the results are both more difficult with a deck cargo. A spill is bad enough on a clear deck but is virtually impossible to clean up below a cargo of logs. There is also the likelihood of cargo claims from logs impregnated with fuel oil.

All cargo lifting equipment should be thoroughly inspected and any damaged and worn wire ropes replaced. Weights of logs are generally not known, and logs loaded from the water can be much heavier than expected especially if they have been in the water for some time. Cargo gear is likely to be worked hard and any weaknesses will soon be found.

Lines should be painted on the deck in a distinctive colour to indicate the maximum limits of the deck stow and areas to be left clear of cargo. This is to ensure that sounding pipes remain accessible, mooring winches remain usable, the pilot can board in safety, and deck lockers and machinery entrances are accessible.

Cargo lashing equipment should be sorted and placed in position, shackles and turnbuckles greased and laid clear of the cargo area so that they are not overstowed. Do not leave this job until the last minute. It is better to sort everything out before arriving in port since after arrival the deck will be cluttered with stevedores. Hatch cover protection should be made available. Some vessels place plywood sheets or dunnage over the hatch covers and then lay old mooring ropes or similar athwartships across the covers to prevent damage.

Following incidents of ships listing heavily when water flooded back into topside tanks, the IMO have issued a warning that screw-down overboard drain valves fitted to topside ballast tanks (dump valves or drop valves) must be closed whilst loading timber and whilst at sea. Access to the valves must remain free at all times. The internal structure of the holds should be inspected for damage and repaired if defects are found. Hold sparring and pipeguards to protect internal hull members should be in place.

Loading logs in the holds: Logs should be lifted aboard close to the ship and should if necessary be steadied against the hatch coaming before lowering into the hold, to minimise swinging. It is usual to load fore and aft, as far as possible, so that in the event of cargo movement logs do not act as battering rams against the ship's side if she rolls heavily.

Care must be taken when placing the first tier of logs on the tank tops so that a good level stow is achieved, broken stowage (i.e., empty space between logs) is kept to a minimum and logs are not landed heavily, damaging the tank top plating and internal framing. While it is important that deck officers pay close attention throughout cargo operations so that any damage does not go unnoticed, it is essential that the stevedores are closely supervised during the initial period of cargo operations when any incorrect use of cargo equipment or reckless handling of cargo can be rectified. It also establishes the relationship between the ship's officers and the stevedores and ensures there is no misunderstanding as to the standard of work expected.

Logs stowed fore and aft should be placed towards one end of the compartment. If the space is long enough, a further stow of logs laid fore and aft should be placed towards the other end of the compartment, and any space remaining in the middle of the hold between the two stows should be filled with logs stowed athwartships. If the hold is only long enough for one stow of logs fore and aft, any space which remains at the other end of the hold should be filled with logs stowed athwartships. The athwartships stow should be completed tier by tier as loading progresses. (It is reported that in the West African log trade logs are never stowed athwartships.) Butt ends of the logs should be alternatively reversed to achieve a more level stowage except where excess sheer on the inner bottom is encountered.

Snatch blocks and bull wires should be available to ensure that logs are stowed out to the ship's side and broken stowage is kept to the absolute minimum. The blocks must be attached to suitably reinforced padeyes and eyebolts and the gear must not be overloaded. It is important to stow as much of the cargo as possible in the holds as wasted space can, for reasons of stability, reduce the tonnage of cargo which can be loaded on deck. A tight stow below and within the hatch coamings should be achieved by the use of smaller logs if they are available.

If loading direct from the water or if heavy rain occurs during loading, bilges should be sounded and pumped frequently. Apart from causing errors in stability roll tests and deadweight calculations, significant quantities of water in the holds will when the vessel moves in a seaway mix with bark and other debris and can become a thick emulsified mass which is virtually impossible to pump out.

On completion of loading the holds ensure that all hold lighting is isolated, hold access hatches are securely battened down and cargo will not interfere with the securing of the hatch covers.

Loading on deck: Lighter, longer, logs should whenever possible be kept for deck stowage for both stability reasons and the ease of securing. Shipside timber stanchions should be rigged and secured in position and lashing equipment kept clear of the loading area and free to be pulled over the cargo on completion.

The area between the hatch coaming and the ship side stanchions must be carefully stowed with the longest logs at the ship side and these logs butted-up to each other. This helps to present a smooth surface at the outside of the stow to any seas breaking on board and therefore reduces the likelihood of logs becoming displaced in heavy weather. The stow must be kept as compact as possible.

Loading on the hatch covers must be done with great care to avoid damage. Deck officers must remain conscious of the danger of damage to hatch covers, hold access hatches and hold ventilators. If such damage remains undetected under the stow it could allow large quantities of water to enter the hold in adverse weather with potentially disastrous results.

Experience of the vessel and trade will indicate when checks on the vessel's stability are required, but in general a check should be made before loading of the deck cargo is commenced. Drafts should be monitored regularly and tonnages of cargo loaded should be computed and recorded. From the information thus obtained deck officers will soon gain the ability to estimate the quantity of cargo loaded even if the individual weights of logs are unknown.

The deck stow must be completed with the centre slightly higher than the sides and ideally curved from the centre to the ship side so that the lashings are in contact with the logs across the whole surface of the stow. It may be necessary to stop loading before maximum cargo has been lifted, to ensure that loading ends with a complete tier of logs with the required curved surface.

A method sometimes used to strengthen and bind the stow and to support the ship side timber stanchions is a 'wiggle wire'. This is a wire rope about 20 mm diameter, secured at one end half way up a ship side timber stanchion, then passed across the stow to a stanchion on the opposite side where it is passed through a shackle at the same level and then back across the stow to the adjacent stanchion via a shackle and so on, until the stow at that hatch is covered and the end of the wire is secured to a stanchion. The result is a slack wire zigzagging across the logs, secured at each end, which becomes tight when the next tier of logs is loaded and the wire is pressed down in the curve between the logs underneath. It consolidates the stow, acts as a secondary lashing system and pulls the ship side timber stanchions inboard at half their height, which reduces the risk of the stanchions shearing at their bases.

If the deck is completely covered with deck cargo leaving no path along the deck from forward to aft, and if the ship possesses no pipe tunnels or other underdeck walkways extending the length of the ship, a temporary walkway must be provided over the deck cargo.

Stability: In practice there are two possible methods of calculating the vessel's stability when loading a cargo of logs. Conventional trim and stability calculations must be made and these can be checked by calculating the GM from a roll test.

Trim and stability calculations are difficult when the weights of individual logs are unknown. For that reason every item which can be checked should be assessed with care. The contents of tanks and bilges and the constant should be carefully measured and calculated. Accurate figures should be used for the space occupied by the cargo, on deck and below deck, when calculating the positions of the centres of gravity of the cargo. Because some space is always lost below the deckheads it is safe to assume that the cargo is homogeneous, and that its centre of gravity lies at the geometric centre of the hold, unless it is clear that heavier logs have been loaded at the top of the stow.

Frequent checks are required on the vessel's draft during loading to ensure she does not trim by the head, especially if a maximum deadweight cargo is to be lifted and ballasting cannot be used to provide stern trim.

When considering the minimum stability acceptable for the passage to the discharge port several factors should be taken into consideration apart from the minimum criteria stated in the vessel's stability book. Has the deck cargo been loaded in a dry condition? If so an allowance must be made for water absorbed by the deck cargo. Is the hold cargo very wet? If so allowance must be made for loss of weight as water from the cargo seeps into the bilges and is pumped out. Is the deck cargo tightly stowed? If not can significant quantities of water be held on deck if seas are shipped on board? Ensure there is adequate reserve stability. Will the vessel pass through an area where icing could occur? Allowance must be made for additional weight of ice on top of the stow. Will the free surface effect increase during the voyage due to use of additional tanks? A ballast tank which is full can become slack as a result of spillage caused by rolling, or a large change in temperature.

When loading of the holds is completed, a careful draft check must be made to permit calculation of the weight of cargo loaded. At this point the ship's stability can be calculated with reasonable accuracy and the maximum cargo to be loaded on deck can be established. As a check on the vessel's stability calculation, a roll test can be conducted and used to calculate the GM.

The vessel must be made to roll and to achieve this, if alongside, all moorings must be slacked, gangway lifted, cargo stopped and all cargo gear brought to as near the seagoing position as reasonable, except for one crane or derrick amidships which should be swung well outboard with a heavy sling of cargo attached. Raising and lowering the sling from the quay will soon induce the vessel to roll, and when rolling gently the sling should either be bought quickly inboard and landed on the centreline, or landed on the quay and the hoist wire kept slack. The size of roll has no effect on the period of roll. As soon as the vessel is rolling freely the period of roll-i.e., the time taken from maximum roll one side to that same position again-must be carefully timed over several rolls.

If the vessel is at anchor in calm conditions, the same measurement can be undertaken, the rolling being induced by lowering and raising a sling of cargo in and out of the water. Ensure that all lighters are clear from the ship side as their moorings will affect the period of roll.

The accuracy of the roll test will be reduced if the vessel's freedom to roll is restricted in anyway and also if a large free surface effect is present in bunker or ballast tanks. In the latter case it is best to assume that the GM obtained does not include the effect of free surface and to correct the GM for free surface effect.

The formula used to calculate the approximate GM is: $GM = F/T^2$, where GM is the metacentric height in metres or feet (i.e., whichever units are specified in the ship's documentation); F is a ship's figure to be determined by the ship's administration and given in the ship's loading manual (this figure is derived from the ship's transverse radius of gyration which depends upon her dimensions and condition of loading); and T is the period of roll in seconds.

When the GM has been calculated from a roll test it is important to consider the other measures of stability for the worst condition before concluding that the ship is entirely safe. These measures include the areas under the GZ curve (the dynamic stability), the range of stability up to the angle when positive stability vanishes and the ship will capsize, and the angle at which the maximum righting effect occurs, which should be above 30 degrees of heel. (Calculation of these values is shown in Appendix 10.X.3.)

During the voyage: Lashings on deck cargoes of any nature require checking frequently, but deck cargoes of timber and logs in particular require tightening, sometimes as often as two or three times a day during the first days of a sea passage as the vessel's movements cause the stow to settle. Considerable shrinkage can also occur if the logs have been lying in water for some time before being loaded; therefore even after the initial slack has been taken up lashing must be checked and tightened daily and this process recorded in the deck log book.

The ship's period of roll should be checked regularly when the ship is rolling in a seaway and the GM should be recalculated. In these conditions the results can only be approximate since the period of roll may be affected by the waves, by the vessel's speed and by rudder action. If it is found that the positive GM is becoming too small the reason must be sought since at the start of the voyage calculations should have showed that there would be sufficient stability throughout the voyage. The explanation may lie in careless procedures aboard ship, which have allowed too many slack tanks to occur, or inaccurate calculations which concealed a lack of stability. Another possibility is that a compartment has become flooded. When the cause of the loss of stability has been found appropriate steps can be taken.

Holds containing timber should only be entered when they have been ventilated and the good quality of the air has been confirmed. Where doubt remains self-contained breathing apparatus must be worn by all persons entering the space.

Retractable tweendeck vessels

Several shipbuilders have produced vessels with tweendecks which can be used in two alternative modes. When the tweendecks are lowered into position the ship operates as a tweendeck vessel; when the tweendecks are drawn up, unshipped or retracted, the vessel becomes a single-deck bulk carrier. This provides a useful flexibility in operating, but naturally incurs a higher initial cost and a greater maintenance requirement.

One feature shared by several designs of retractable tweendeck vessel is that the space available for cargo is diminished when the tweendecks are retracted. This causes no problems when a high-density cargo such as ore is carried, since not all the space is required, but has given rise to disputes when cargoes of sawn timber are carried. When the tweendecks are retracted for the stowage of bundles of sawn timber such space as is available is used more efficiently, but the space available is reduced. The ship's bale capacity is normally quoted for her condition with the tweendecks lowered. With the tweendecks retracted the bale capacity may be reduced by 5 per cent though the precise figure will vary from one design to another.

Freedom Mark II vessels: The Ishikawajima-Harima Freedom Mark II vessels are 17,000 tonne deadweight vessels fitted with hydraulically-operated retractable tweendecks which fold up to the ends of the holds (Fig. 18.5-see page 219). When the hatches are lowered, tweendeck space is available in the wide hatch square and hatch ends; the small wing spaces are permanently used for pipe passages. When the tweendeck hatches are retracted the tweendeck is converted into a straight-sided graintight feeder space for the hold.

TD15s: The TD15s built by Astilleros Espanoles SA are 15,000 tonne deadweight vessels. Hinged portions of the tweendeck are raised to meet the hatch coaming, thereby forming upper wing tanks which can be used for the carriage of grain (Fig. 18.5). The portable pontoons from the hatch square which form the remainder of the tweendeck must be stowed elsewhere, usually along the sides of the main deck, when the ship is in single-deck configuration. Pontoons which are stowed permanently or semi-permanently on the main deck are liable to suffer from excessive corrosion. On these vessels the removal and replacing of the pontoons and the raising and lowering of the hinged sections of the tweendeck are done with the assistance of the ship's own cargo gear, the lifting of the tweendecks being done by passing hauling wires through manholes set in the main deck and sheaves under the deckhead.

If the ship continues to operate in one mode, particularly the single-deck mode, for a period of months or years as is quite possible, the equipment required for converting the ship and for operating her in the alternative configuration is likely to be neglected. It is important that this is not allowed to happen, and that operating systems are tested from time to time and equipment is labelled, maintained and kept in safe storage for when it is next required.

Munck gantries

A Munck gantry provides a base for a shipboard crane. Each gantry, of open steel construction, consists of an horizontal span supported on two pairs of legs. The gantry straddles the ship's holds, each pair of legs resting on rails which run the length of the deck to port and to starboard of the hatch covers. The gantry is equipped with extensions (wings or arms) at each end of the horizontal span. When extended telescopically they project over the ship's sides.

A top platform with cab beneath it is situated on a bogie and able to travel the length of the span. Also on the platform is the winch with four hoist wires on grooved barrels, each driven by an electric motor. The wires have at their lower ends the lifting head which can be used with a grab or hook. The operator can raise or lower the load and can rotate it in some cases through 360°. He can move the load athwartships by moving the cab along the span, and can move the load fore and aft by driving the gantry along the deck. Movement along the deck is driven by rack and pinion gears, but the weight of the system is borne on railway-type wheels running on rail tracks.

The cranes are electrically driven, the full range of movements requiring a total of 10 motors (one in each leg, two for athwartships movement, four for raising and lowering of the lifting head per crane). Electricity for the various powered units is provided by electric cable stowed on special self-tensioning drums which can respond to the various movements of the parts of the crane, paying out and reeling in as necessary.

The extending and retracting of the gantry arms is achieved hydraulically, as is the jacking up of the cranes before they are parked, or stowed for sea. Hydraulic rams in the four legs of the crane unit are used to raise or lower the hatch lids (covers) which may weigh 100 tonnes, and must be carefully adjusted to lift uniformly. When raised a lid is moved to another hatch and stacked on top of the lid for that hatch.

Each crane fitted aboard a 42,000 dwt vessel weighs about 360 tonnes without load and may have a safe working load of 32 tonnes. Such a bulker with nine holds will normally be equipped with two Munck gantries. When not in use and when the ship is at sea the gantries are stowed in the aftermost position against the bridge front with their arms retracted.

The gantries and cranes have a reputation for providing a fast, flexible, reliable and efficient service for the handling of bulk cargoes, forest products and containers.

Maintenance: The maintenance required for cargo gear in general is described in Chapter 23 and includes regular greasing and oiling, and inspection of wire ropes, sheaves and other moving parts. Munck gantries, like other cargo gear, require this treatment. In addition, the self-tension drums for the electric cables must be maintained in good working condition, well greased and free of loose scale, to ensure that the cables do not become slack and get snagged or overtight and broken. The gantries must be kept free of loose scale which could fall on deck and injure someone passing below.

The great quantity of hydraulic piping must be checked and tested periodically for leaks. Since the hydraulics are used for the rigging and unrigging of the gantry and are not required during cargo work, hydraulic repairs are done immediately only when they can be done without interrupting cargo or when they are causing immediate problems. Normally, they are completed during the first normal interruption to cargo to avoid incurring any delay which could be blamed on the ship. The hydraulic rams must be removed occasionally for renewal of rings and packing, a job which can be done at the time of the vessel's drydocking.

Since each crane uses ten motors, there is a need for a great deal of high quality electrical maintenance.

The drive motor in each of the four legs incorporates a set of disk brakes.

Manual safety stops and cutouts: Bells and flashing lights are fitted to each leg of the Munck gantries to give warning when they are moved. They should be regularly checked. It has been known for rags to be stuffed into the bells to stop the racket which they create.

Manual safety stop buttons are situated at the base of each leg of the crane and also on the top platform and in the driver's cab. They are clearly marked and are to be used in emergency, such as if someone gets in the way of the moving crane. They have the effect of instantly cutting off power from the hoisting and crane moving motors. Once the safety stop buttons have been operated, they must be reset by ship's staff in the main powerhouse of the crane.

Safety cutoffs are fitted at the ends of the gantry arms to stop the cab and hoisting gear from going off the end of the arm. Similar cutoffs are fitted for the fore and aft movement of the crane, to stop cranes from colliding with one another or with the accommodation housing or the end-of-line buffer pads. The considerable weight of the cranes makes these precautions essential to prevent damage to the crane or the structure collided with. Safety cutoffs in the hoist system prevent the lifting head being raised above a preset height.

Wires and lifting gear: The cranes are fitted with four wires to each lifting head for maximum speed and load. When grabs are used two of the wires are reeled off, since the grabs are designed for two-wire operation. When in use the wires stow on grooved drums.

The cranes can be made multipurpose by the fitting of an assortment of different lifting heads. Bulkers fitted with Munck cranes and employed on regular trades can be provided on arrival in port with appropriate lifting heads which are the property of the stevedores and have been maintained by them. Such heads can include: various types and sizes of grabs: pneumatic vacuum clamps used to lift 12/14 rolls of newsprint; pneumatic lock-and-release pulp heads of various sizes; container heads for 20ft and 40ft containers; lumber legs for handling packaged lumber.

Stowage: When parked for sea the cranes are lifted hydraulically and screwed down by hand in fixed positions, with the screws held in place with hydraulic pressure. This prevents damage to the flat tracks and to the racks and pinions whilst the ship and gantries work in a seaway. In heavy seas the top portions of the gantries tend to sway both fore and aft and athwartships due to their height and to the fact that they are only secured at deck level.

Trim calculations: All trim calculations must be undertaken with the gantries in the stowed position and with the positions of all hatch covers included in the calculations, since the positioning of these heavy items can have a considerable effect on the trim.

Combination carriers

A combination carrier is a ship which has the ability to carry either an oil cargo or a dry bulk cargo. Such ships cannot carry the two cargoes simultaneously although when trading as dry bulk carriers a quantity of slops (residual washings of oil and water from which the excess water has been removed) may remain aboard. There are two basic types of combination carrier.

Ore/bulk/oil carriers: (OBOs) (Fig. 1.36) have a basic design which is similar to conventional bulk carriers and are provided with upper wing tanks (topside or shoulder tanks) and with lower wing (hopper) tanks. The lower wing tanks are combined with the double bottom tanks and sometimes are extended up the ship's side to meet the upper wing tanks, thus providing a narrow double skin at the ship's sides. Duct keels are fitted and one main deck cargo hatch opening per hold/tank is provided. The slop tanks are most commonly the after pair of upper wing tanks adjacent to the aftermost hold. OBOs can carry a full oil cargo by deadweight or by volume, or a full dry bulk cargo of high or low density, so that ore, coal or grain can be carried.

Ore/oil carriers: (Fig. 1.37) are similar in layout to conventional tankers with centre and wing tanks, but the centre tanks are provided with a double bottom, a duct keel is usually provided, and dry cargo can be carried only in the centre cargo spaces. Steel hatch covers are fitted on the main deck but as the centre tanks extend to only about half the beam of the ship the hold length is generally twice that of an OBO hold and each hold will have two hatch openings. The slop tanks in these ships are usually the aftermost wing tanks, adjacent to the pumproom. Such vessels have the ability to carry either a full oil cargo, both by deadweight and by volume, or a full dry bulk cargo by deadweight provided that the dry cargo is heavy (with a stowage factor of no more than 0.57/0.62m^3/tonne-20/22 ftVtonne) and can be accommodated in the appropriate holds/tanks. The ore/oil carrier is less versatile than the OBO, and can carry a smaller range of dry bulk cargoes. Whilst there are variations in the design of combination carriers the two basic types described above are distinct.

Combination carriers trading as tankers and bulkers: When considering the operating of combination carriers as dry bulk carriers it is necessary to be aware of the way in which they are operated as tankers. The following paragraphs consider the effects of the carriage of oil and dry bulk cargoes. Whilst oil pollution is an obvious hazard when carrying oil, the greatest danger comes from the explosive gases given off by crude oil. Migration of even small quantities of oil through small fractures into ballast tanks, void spaces and duct keels is often hard to detect, but removal of any such leaked quantities of oil is essential to prevent generation of gas. This matter requires continual vigilance, and a number of precautions are described in the following paragraphs.

Heating coils: Combination carriers when trading as tankers may carry crude or fuel oils. Fuel oils and some crudes have to be heated. This is done with steam coils, which in an ore/oil carrier are fitted in the wing tanks and in an OBO are usually fitted within the stool spaces (the void hopper spaces at the bases of the athwartships bulkheads) against the plating which forms the hopper side. Leaks can and do occur and oil may be carried back by way of the steam return lines into the condenser. It is good tanker practice to test heating coils by pumping fresh water through them at a time when they can be inspected to detect any leaks. If leaks have been detected or are suspected the lines should be flushed through to remove any gas before changing from oil to dry cargo.

Loading: To load an oil cargo shore pipelines are connected by flexible hoses (or chicksans) to the ship's cargo manifold which is normally located about amidships. The oil is then carried in fixed pipelines aft along the deck and down drop lines into the ship's bottom lines, which lead to all the cargo tanks. The flow into each tank is controlled by main line valves situated on the line itself, with the controls either on deck or in a cargo control room. The cargo quantity loaded is measured by ullage and tanks are filled to about 98 per cent capacity, which usually brings the surface of the oil to the base of the hatch coaming. Ullage measurements are taken from an ullage port which may be set in a pedestal abaft the hatch lid, or may be situated in the centre of the hatch lid.

Official draft surveys are rarely carried out aboard tankers, but it is good practice for the ship's personnel to undertake their own draft survey when an oil cargo is on board, to identify constants and additional weights. The records of such observations will be useful for comparison on a dry cargo voyage if differences arise between ship and shore.

Discharging: The bulk of the cargo is discharged through the main lines, by way of the main turbine cargo pumps which push the cargo up to the deck lines and through the manifold into the shore line. The final bottom quantity of oil (i.e., the residue which the main pumps cannot pump efficiently) is discharged by eductor or by stripping pump, the latter being a small reciprocating pump operating through its own line, and drawing oil from a bilge well set into the inner bottom when the tank is placed over a double bottom. The same stripping lines and pumps serve as the bilge system for the cargo holds when the ship is operating in the dry cargo mode.

Inert gas: Before loading an oil cargo the empty cargo tanks will be filled with an inert gas (directly from flue gas in a steam ship and from a gas generator in a motor ship) and the excess of this gas will be vented as the tanks are filled with oil (to avoid over-pressurisation). The ullage space above the oil will be kept in an inert state, with oxygen levels below explosive levels, throughout the voyage. As the oil cargo is discharged inert gas is generated and fed into the tanks, so that when empty the tank will still be fully inerted. When the vessel is carrying dry cargo the inert gas lines to the cargo holds will be blanked off, these blanks being fitted in a position adjacent to the hatch coaming.

Crude oil washing (COW): During discharge of a crude oil cargo, to reduce clingage of cargo to the structure, oil is bled from the deck discharge line and fed through a fixed piping system to tank washing machines fixed within the cargo tanks. These machines rotate in two planes in accordance with a time programme to back wash the tank, using cargo for the washing. Whilst washing, the residues are stripped out to one of the slop tanks from where they are discharged to the shore along with the balance of the cargo. The COW procedure is not adopted with fuel oil or heavy, heated, crude oils because remnants of the cargo which cooled in the washing system would block it. When washing with crude oil the inerted atmosphere must be maintained. COW can only be carried out in port whilst discharging an oil cargo.

Load on top: If a full crude oil wash is not carried out the remnants of the last oil cargo clinging to the tank structure (the clingage) can be several hundred tonnes, particularly in the wing tanks of an ore/oil carrier, as most of the structural members are within the wing tanks leaving the centre hold/tank smooth sided. During the ballast voyage some of this clingage slowly flows down and can be stripped into the slop tank. Any slops which remain on board will be in the slop tank when the vessel is presented to load the next oil cargo.

Voyage orders will always contain an instruction as to whether the next cargo is to be segregated from the slops, or can be loaded into the slop tank and co-mingled with the slops, a process known as loading on top of slops. Slop tanks are located aft, and it is usually preferable to load them to avoid any tendency to trim by the head. The slops will, if the ship loads on top then be discharged with the next cargo. If this cannot be done the ship will accumulate an increasing quantity of slops, thus reducing her subsequent cargo lifts.

Water washing: It is necessary to clean the tanks/holds thoroughly when changing to dry cargo or when they have to be entered. A thorough cleaning is achieved by washing with sea water after crude oil washing. The washing is usually done with hot water heated either through a fitted water heater or in one of the slop tanks. When water washing is taking place the stoppings are pumped into one of the slop tanks where the oil and water are allowed to settle out, after which most of the water is pumped into the sea leaving the slops, which may be 80/90 per cent oil, with the balance of the water.

Washing machines: In tanks used only for the carriage of oil the washing machines are permanently fixed in position although they can be lifted out (vertically) for maintenance. In tanks/holds which can be used to carry oil or dry cargo the machines must be withdrawn before dry cargo is loaded to prevent damage to them. Before the introduction of fixed machines and COW the normal method of washing was by Butterworthing (a trade name for the machine, for which alternatives include Victor Pyrate and Dasic) using rubber hoses and portable machines that were lowered through holes in the deck.

Some ships still carry a set of these machines which are handy for local cleaning and can be used with chemicals for difficult cleaning jobs such as occur following discharge of fuel oil in exceptionally cold waters. The rule of thumb is that the water should be at a temperature of 180°F and a pressure of 180 psi, but good results can be expected provided these two values total at least 300.

Hatch covers: The hatch covers on combination carriers are normally of the same basic design as those of conventional bulk carriers, side rolling covers being most common. Such covers on combination carriers possess three distinctive features. They are provided with special oil resistant seals, Butterworth plates (for

SPACES REQUIRING PARTICULAR CARE WHEN GAS FREEING A COMBINATION CARRIER

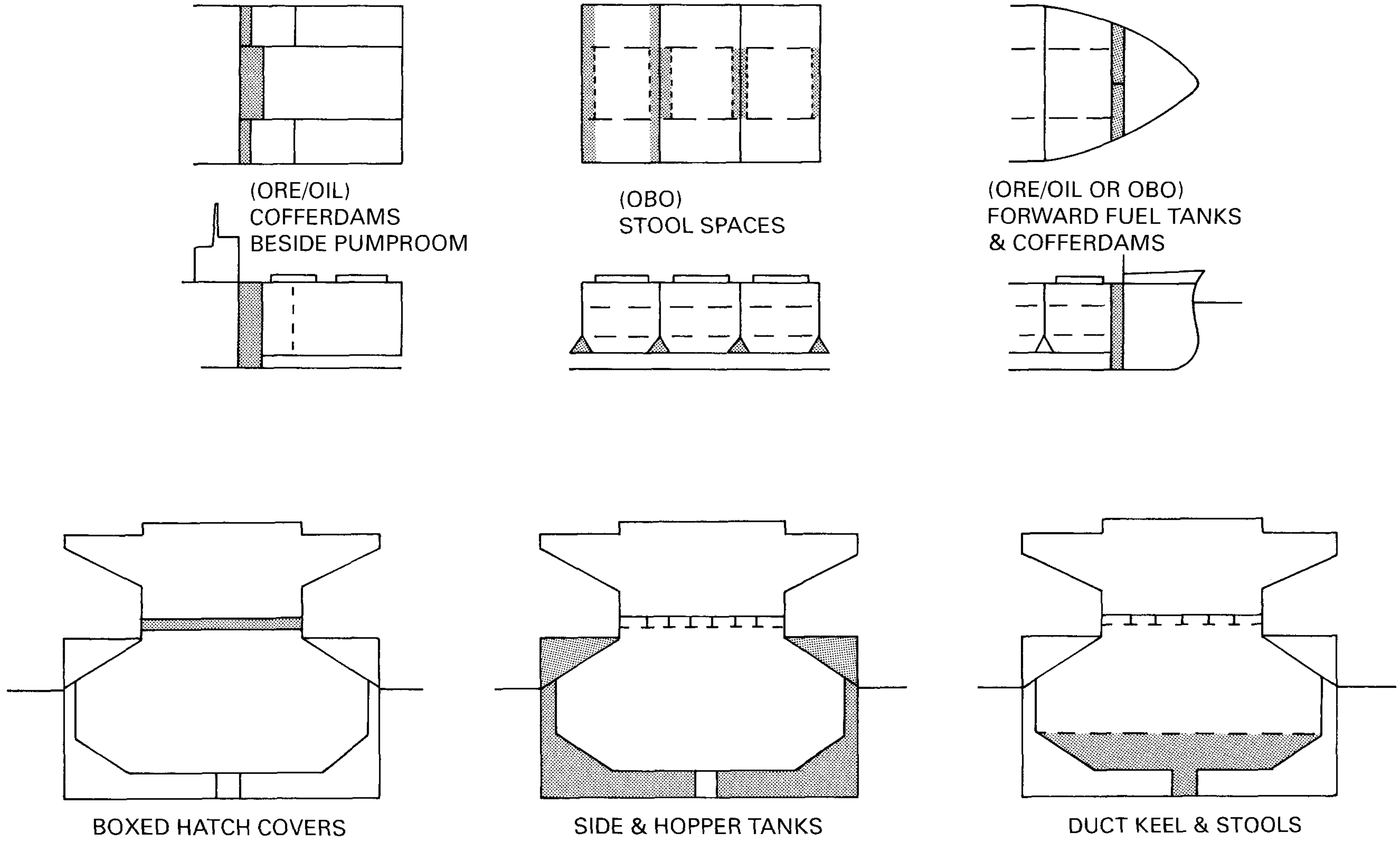


FIG 18.4

portable machine washing or portable vents) are fitted at each corner of the hatch covers, and the covers are designed to resist hydrostatic loading from below, an effect which is usually achieved by providing an increased number of cleats.

Some steel weather deck hatch cover panels are plated, fully or partially, on the underside. Any fractures in this underside plating can allow oil and gas to enter the space inside the panel. Such hatch covers must be carefully examined for fractures when they are open and if drain holes are fitted these should be used with an explosimeter to test for hydrocarbon gases. If gas is found the panel air plugs should be removed and the cover should be blown clear with compressed air.

When the fractures have been repaired, the cover should be re-inerted, using vapour phase inhibitor (VPI) tablets. These tablets, which are removed from a canister and poured into the enclosed space via an air hole, have a twofold action: they produce an inert gas and absorb oxygen. Once the gas is seen emerging from both the air holes these holes must be again plugged and sealed, thus effectively inerting the enclosed space.

When changing from dry cargo to oil the normal side rolling hatch covers can only be properly cleaned when in the open position. When making this change particular care must be taken in cleaning the hatch coaming plate and compression bar to avoid dry residues damaging the neoprene seal when the hatch cover is tightly closed.

Instructions: Since the introduction of the Marpol Regulations all ships carrying oil have been provided with an *Operating and Equipment Manual* which gives full descriptions and capacities of pumps, COW and inert gas systems. Routines for cleaning after oil cargoes are laid down in this manual, and these provide detail of the time required for washing cycles and other routines. Most owners and managements supplement this manual with their own guidance, and the builders often provide a changeover procedure for the change from oil to dry cargo or vice versa. It is essential that all these documents are read with care so that all restrictions which are listed therein can be complied with.

Following a series of explosions which occurred in combination carriers and tankers some years ago whilst tank cleaning was in progress it has been the practice of prudent owners to lay down a schedule of reports required from the ship at stages in her programme. There is likely to be a requirement to report commencement and completion of tank washing, the gas free status of the ship en route to the loading port and at the time that notice of readiness is tendered, and the times when any maintenance work is being carried out on deck or in the tanks/holds.

Equipment: The equipment and instruments which are provided to enable the combination carrier to operate as a tanker must be in working condition from the moment that she commences to change from dry bulk to oil cargoes until such time as all hydrocarbon materials and gases have been found to have been fully removed and all spaces have been checked daily for gas with negative results for a period of two weeks. Equipment affected by this requirement includes gauges and read-outs, the inert gas system, the crude oil washing system, cargo pumps and oil content monitors.

Of particular importance are the portable gas detectors for explosive hydrocarbon gases (the explosimeters) which indicate whether at that time and in that condition there is an atmospheric mixture present in the space which is explosive. Equally important are the oxygen analysers used to detect the level of oxygen in a space. When a explosimeter is used to test the atmosphere before entry into an enclosed space the oxygen level must also be checked and confirmed as being safe for entry.

Slop tanks: Every effort must be made to minimise the volume of solid dry cargo residues that are washed into the slop tanks as these will cause problems later. Once in the slop tanks such residues may settle on the tanks' valve seats, or be put back into the cargo tanks by way of the washing machines, or eventually be discharged from the slop tanks together with the oil which has been gathered therein. Each of the foregoing possibilities is undesirable, but tank washing by recirculation (collecting the washings in slop tanks, allowing the oil and water to settle and then using the water again by drawing it from low in the tank) is usually unavoidable. To avoid or minimise these problems a main cargo tank can sometimes be used for the washings. This is possible provided that later in the voyage the ship will pass through an area where the washings can be decanted to the sea, after which this final tank must also be washed.

OBOs in particular face problems arising from the fact that the upper wing tanks are used as slop tanks. Such tanks have a small capacity and a shallow depth, which makes it difficult to achieve efficient settling out of the oil and water and results in oil being carried back with the washing water, giving less efficient cleaning.

If at all possible no slops should remain aboard on completion of an oil discharge. If the previous oil cargo was not loaded on top and some slops do remain, every effort must be made through charterers and owners to land these slops before commencing the changeover to a dry bulk cargo. If any slops remain on board they have the effect of putting one of the slop tanks out of service, which will create problems when cleaning after dry bulk and oil cargoes. They also reduce the vessel's cargo deadweight capacity.

When all cleaning has been done and the excess water has been removed from the slops leaving them in one slop tank only, the ventilation arrangements for that slop tank must receive attention. If the slop tank is blanked off from the inert gas system at this time the procedure often consists of fitting an additional section of vent piping to extend the vent to a high position, perhaps under the bridge wing. Alternatively, the tank should be kept inerted if crude oil remains within the slops.

Empty wing tanks: Tanks, such as upper wing tanks in OBOs and side wing tanks in ore/oil carriers that have carried crude oil but are not to be used for the carriage of dry bulk cargo, must be efficiently washed to the point where insufficient traces of oil remain to generate gas. In this connection it must be remembered that a changeover in a cold climate followed by a dry bulk voyage which takes the ship into a hot climate is likely to create conditions which encourage the formation of explosive gas within the empty oil cargo tanks. Consequently, they must be regularly checked during the voyage for any signs of gas. If gas is detected the tank must be ventilated. If the tank is not clean enough to prevent the formation of gas it must be washed again.

The upper wing tanks in an OBO may well be used for a grain cargo and the oiltight manhole covers have to be removed after the compartment has been cleaned and vented. Some ships have grilles to fit in place of the manhole covers. Loose nuts must never be left in these tanks as they will damage grain suckers or ship's pumps if sucked into either discharging system.

Hold washing: An increasing number of countries with estuarial waters are introducing prohibitions on the washing of dry cargo residues into the sea and a change from coal to oil between (say) Antwerp and Rotterdam presents problems in the disposal of the coal washings. It may be that the long-term solution to this problem is to have a dry cargo washing residue tank in which residues could settle and from which water could then be removed, allowing the solid residues to be disposed of in the open ocean or ashore as appropriate. (Meanwhile this problem is shared with all bulk carriers, and is discussed in Chapter 25.)

Duct keels: A large number of ships have suffered severe flooding and some have even sunk as a direct result of the access manholes of duct keels being left unsecured. The aftermost entrance to the duct keel of a conventional bulk carrier is usually located at the fore end of the engineroom, and a bolted plate is provided to seal and secure it. Access to the duct keel will also be possible by way of a ladder in a trunkway from one or several positions between hatches on the main deck, such trunkways often being built into a corrugation in a transverse bulkhead.

In combination carriers, because the pumproom forms the cofferdam between engineroom and cargo spaces, access to the duct keel is usually gained from the pumproom by a bolted hatch. In some OBOs the stool spaces are common with the duct keel whilst in others access between duct keel and stool space is by manhole.

While oil is being carried and after an oil cargo until the vessel has been found for two weeks to be gas free, any electric lighting in the duct keel must be isolated by withdrawal of the fuses. Under no circumstances should double-bottom access manhole covers located within the duct keel be removed for the venting of tanks when electric lighting or electric fan power sources are live. If the design of the ship makes it necessary to carry out venting by way of the duct keel, the air inlet and not the air exhaust must be provided in the duct keel to prevent gas from entering the duct keel.

Changing from oil to dry cargo must include full checks of the duct keel and the stool spaces, which may be common with the duct keel, for the presence of gas. When the ship is at sea access hatches to duct keels, whether from engineroom or pump room, must be kept fully closed with all bolts in place and fully tightened. The ship may be held to be legally unseaworthy if damage results from the flooding of a duct keel which has not been properly closed.

Miscellaneous matters

Some dry cargo ports require a certificate issued by a chemist before the combination carrier is allowed to enter the port or commence loading. Whenever such an inspector can be obtained he will provide valuable support for the ship in the event of any disputes, provided that he takes readings from all spaces regardless of whether they are dry cargo spaces, dry spaces where oil was previously carried, ballast tanks or void spaces.

Enforcement of smoking restrictions that are familiar to tanker crews is best continued when the ship changes to dry cargo. It is generally safer to maintain the routines throughout the trading of the ship.

Between successive dry bulk cargo voyages the cleaning routines will be the same as for a bulk carrier. In addition routine checks of all spaces for gas must continue, particularly when the ship moves to warmer climates.

The standard of hold cleanliness required for most fertilisers including phosphates, and for sulphur, is for all practical purposes the same as for grain. There must be no traces of former cargoes, including oil, and 'no traces' means exactly that. Loose scale is not acceptable but rust coloured steelwork is usually no problem. If traces of oil are discovered during cleaning in positions that are too high to be reached from ship's ladders the owners and/or charterers should be informed so that arrangements can be made for cherrypickers or other suitable equipment for reaching high points to be provided on the ship's arrival at the loading port. Such cleaning is usually done by spraying chemical on to the oil, leaving it for a few hours and washing it off, or in extreme cases by high pressure water washing.

Areas where fractures often occur on combination carriers lie along the boundaries of hopper tanks and stool spaces, and it is these fractures that may allow some oil migration to take place. Every opportunity should be taken whilst holds/tanks are free of oil and gas-free to examine frames and brackets at the ship's side between lower and upper hopper tanks.

Lower hopper tanks and side hopper tanks in OBOs, if horizontally separated from upper wing tanks, may be found to be difficult to clean. In some ships, access manholes are fitted between the upper wing tanks and the side tanks and it may be necessary to remove these to ventilate the side tanks. Gas readings should never be taken through a sounding pipe as the bottom may not be open and clear. In some of these confined spaces it may be necessary to remove the top of the air (and overflow) vent in order to lower the gas sensing tube into the lower part of the compartment.

Changes of ballast will be required during tank cleaning and when ballasting with clean ballast for arrival in the loading port. Inert gas must be maintained until the water washing is complete in all tanks that previously carried oil. Shear forces and bending moments for each ballast condition and for each change of ballast must be calculated and kept within the permitted limits. The tonnage of tank washings which may be accumulated in an empty cargo hold must be calculated and included in the stress calculations.

Fig. 18.4 shows the areas where particular care must be taken when checking the ship for gas.

Sources

17. Tinsley, D, *Shorl-Sm Bulk Trades.* Fairplay Publications Ltd. 1984

18. *Code of Safe Practice for Ships Carrying Timber Deck Cargoes.* International Maritime Organization. 1991

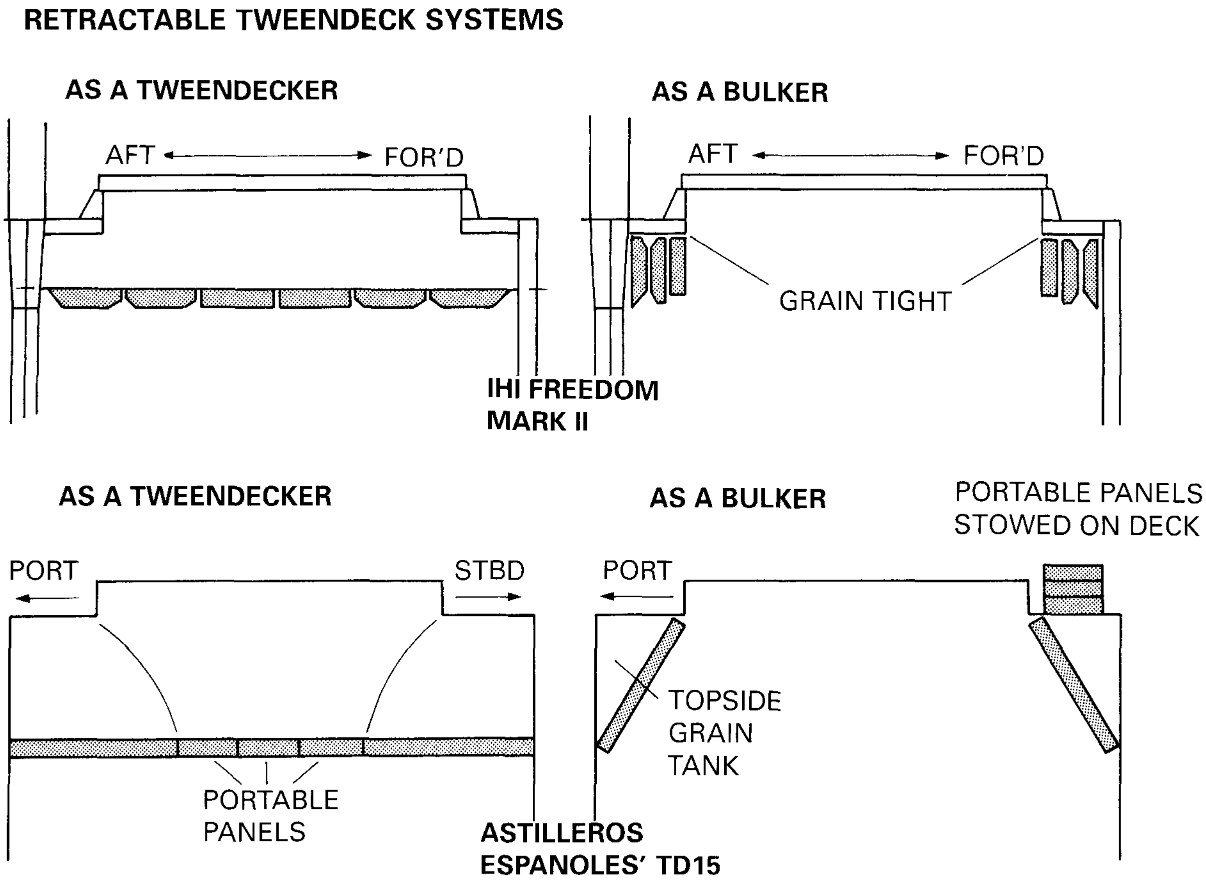


FIG 18.5

CHEKLIST–Procedures for changing a combination carrier from dry cargo to oil

NB: The charter party normally allows two days for this process.

- ☐ Check the procedure with the ship's Marpol Operating and Equipment Manual, and with owners' and builders' instructions.
- ☐ Remove all cargo residues by sweeping and by digging out the bilge wells, since holds will usually only have been shovel cleaned.
- ☐ If necessary the tank top and upper levels of the hopper slopes should be hosed off, as should the inside of the hatch covers in the open position, to avoid a build-up of impacted dry cargo and oil. If time permits the holds can be fully washed, but the charter party often allows only two days for converting from dry cargo to oil and experience shows that dry cargo dust which remains on underdeck beams forward of and abaft the hatch coamings causes no noticeable increase of sediment in the next cargo of crude oil.
- ☐ The bilge well covers must be removed and stowed and the oiltight sealing plates for the grain trimming openings in the upper wing tanks must be refitted.
- ☐ Blank flanges must be removed from the main cargo pipelines.
- ☐ Ullage gauges, if of the Whessoe type, should be refitted with wire guide and float.
- ☐ Tank washing machines must be lowered or swung back into position.
- ☐ Blank flanges must be removed from the inert gas lines.
- ☐ Any hatch cover ventilators must be unshipped and blank flanges refitted.
- ☐ Hatch covers must be closed and cleated down.
- ☐ Gas detectors in the accommodation must be switched on and electric sources on deck and in the duct keel must be isolated.
- ☐ Any blank flanges or spool pieces inserted into the stripping line in the pump room should be removed or the line should be reconnected as a stripping system. This system must have no direct connection to an overboard discharge, except through an oil content monitor.
- ☐ Slop tank vent arrangements should be restored to the standard tanker configuration by isolating the high vent line and reconnecting to the main inert gas system (IGS).

CHECKLIST–Procedures for changing a combination carrier from oil to dry cargo

NB: The charter party normally allows four/five days for this process.

- ☐ Check the procedure with the ship's Marpol Operating and Equipment Manual, and with owners' and builders' instructions.
- ☐ A full crude oil washing should be carried out during discharge, provided that crude oil and not fuel or a heated heavy crude oil was the last cargo.
- ☐ A full water wash of all spaces that have carried oil should be carried out, and all empty spaces such as ballast-only tanks, forward fuel tanks, duct keel, stool spaces and cofferdams must be checked for the presence of oil.
- ☐ Once a complete machine washing of cargo tanks has been carried out the spaces should be ventilated before they are entered. Once access with safety is possible each space should be examined for the effectiveness of the washing and if necessary hand washing, or chemicals, should be used to remove all oil traces.
- ☐ All lines including COW lines, deck lines and manifold crossover lines must be washed as thoroughly as possible and vented.
- ☐ Tank washing machines must be withdrawn from cargo tanks and ullage devices must be disconnected and removed.
- ☐ Main cargo lines must be blanked off in the holds.
- ☐ In the pumproom the bilges must be thoroughly washed and any blank flanges or stool pieces must be fitted to convert the stripping system to a bilge system.
- ☐ Inert gas lines must be blanked off beside the hatch coamings.
- ☐ Cover plates for bilge wells must be fitted and grain trimming plates in upper wing tanks must be removed and replaced by grilles where necessary.

- ☐ All spaces including cargo holds, tanks used for oil cargoes only, ballast tanks and void spaces, must be checked and confirmed to be gas free. This checking with a portable explosimeter must be carried out twice daily at first, then daily, for two weeks, and resumed if the ship moves from a cold into a warmer climate. Nothing must allow this procedure to be ignored or neglected. Any spaces in which an explosive reading is obtained must be ventilated. It may be exceedingly difficult to vent lower wing tanks to a gas-free condition, and to obtain a gas-free reading from them, but both these things must be done.
- ☐ The water content of slops should be discharged as far as possible until a minimum remains and the extended vent must be fitted or inert gas must be maintained in the space.
- ☐ Gas detectors in the accommodation can be switched off only after the ending of the testing period of at least two weeks.
- ☐ Any hatch cover ventilators should be refitted.

REGINA OLDENDORFF - FRAMING IN TOPSIDE TANKS

SIDE FRAMING

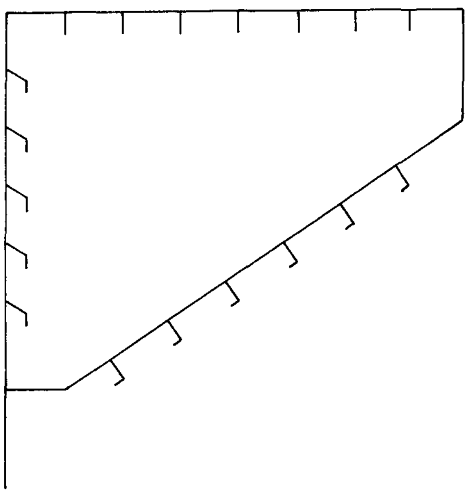


FIG 19.1

WEB FRAME

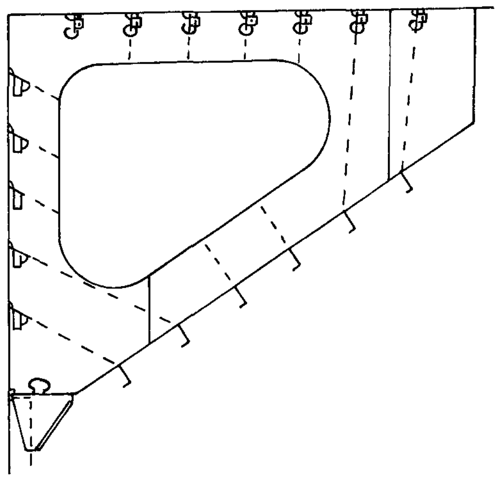


FIG 19.2

FIG 19.3 LUMP ORE *Photograph Courtesy Hamersley Iron Pty Ltd*

CHAPTER 19

CARRIAGE OF COMMON AND TYPICAL BULK CARGOES

Grain, coal, iron ore, steel, forest products

Carriage of grain

IN 1990 about 190 million tonnes of grain was transported by sea, the principal exporting areas being Argentina, Australia, Canada, the European Community and the United States, which between them accounted for 90 per cent of exports[47]. Importing areas include Western Europe, the CIS, the Middle East, Africa and Asia. Much of this trade is carried in Panamax-sized vessels, with the balance being transported in handy-sized and mini-bulkers. The term grain covers wheat, maize (corn), oats, rye, barley, rice, pulses, seeds and processed forms thereof, whose behaviour is similar to that of grain in its natural state[46].

The carriage of grain presents a number of challenges for the shipmaster. Grain is a product which flows freely. It is liable to shift and endanger a ship's stability and for that reason the regulations governing its carriage are exacting. In addition, grain is perishable and is intended for consumption by humans or by livestock. This calls for holds that are very clean and for high standards in avoiding contamination, damage or infestation.

Grain stability: When considering grain stability, the master of a ship required to carry grain has three concerns which do not apply to most other bulk cargoes. He must plan a cargo distribution which satisfies the rigorous stability criteria of the IMO Grain Rules, ensure that the cargo is properly loaded, stowed and where necessary secured in accordance with the Rules, and complete the associated paperwork in a satisfactory manner.

A characteristic of grain is that it flows freely, and the IMO *Code of Safe Practice for Solid Bulk Cargoes*[12] states in Para. 5.2.4.2 that 'non-cohesive bulk cargoes having an angle of repose less than or equal to 30 degrees flow freely like grain, (and) should be carried according to the provisions applicable to the stowage of grain cargoes', taking account of the density of the material. In other words, bulk cargoes with properties similar to grain must be carried in the same way as grain.

The free-flowing characteristic of grain reduces the stability of any ship which carries it. Grain in a partly-filled cargo compartment displays a free-surface effect similar to that of a liquid in a partly-filled tank. If the ship rolls the grain is likely to flow to one side of the compartment, where it will cause the ship to list or to capsize. Conventional bulk carriers are well suited to the carriage of grain, as their design reduces some of the adverse effects of bulk grain upon stability.

The design of the holds of bulk carriers has been developed to create compartments which can be filled to near 100 per cent of capacity without trimming, except for spout trimming by the shiploader. The upper wing tanks occupy spaces into which cargo would not flow, thereby greatly improving the self trimming character of the conventional bulker hold. (Fig. 1.5)

The area within the hatch coaming on a conventional bulk carrier is much smaller than the hold area below, so that the free surface of the cargo is much reduced when the hold is filled with cargo to the top of the coaming. In the *Regina Oldendorff,* for example, the ratio of hatch area to hold area is about 1:3. The coaming, formed of deep vertical plating-with a depth aboard the *Regina Oldendorff of about* 3.0 metres-acts as a feeder from which cargo will flow down to fill any spaces remaining within the hold as the cargo settles during the voyage.

The IMO *Grain Rules*[46] require shipmasters to load their ships safely. For practical purposes the main requirements are:

- A ship which is to load with grain should plan the loading to leave the least possible number of holds part filled. The calculations will show if the proposed loading is acceptable for stability purposes.
- When the loading plan requires a hold to be full all the spaces under the decks and hatch covers must be filled to the maximum extent possible and all necessary and reasonable trimming must be performed to minimise the effect of grain shifting.
- The ends of the holds of a conventional bulk carrier cannot be completely filled by normal spout loading and if they are allowed to remain unfilled the ship's stability is reduced thereby. This is acceptable only if the ship has been found 'specially suitable', and has been issued with a dispensation from trimming ends.
- The master must confirm that the ship's stability satisfies the requirements of the Load Line Rules and also the more rigorous requirements of the Grain Rules, which specify that the angle of heel due to the (possible) shift of grain shall not exceed 12 degrees, that the ship's statical stability diagram satisfied specified conditions, and that the initial fluid metacentric height shall not be less than 0.3 metres. For a ship provided with the appropriate tables these stability requirements can be quickly and easily checked by comparing the actual grain heeling moments with the allowable grain heeling moments (a process described in Chapter 10).
- Before the commencement of loading the master may be required by the government of the country where the vessel is loading to demonstrate the ability of the ship at all stages of the intended voyage to comply with the relevant stability criteria stated in the Grain Rules. In a number of countries this requirement is satisfied by the completion of a form provided by the government concerned.
- After loading, all free grain surfaces in partly-filled compartments must be trimmed level.
- The ship must be upright before proceeding to sea.
- Where the ship has part-filled compartments, and the calculations show that her stability is not acceptable, the surface of the stow in the unfilled compartments must be secured in an approved manner by overstowing with

bagged grain or other cargo or by strapping and lashing. These methods of securing are described in the Grain Rules and descriptions are often included in the ship's loading manual. Securing of the surface of a grain cargo is seldom required in practice since most ships and cargoes are well matched. Readers who require more information are referred to the IMO Grain Rules.

- There may be a requirement to take ballast during the voyage to preserve sufficient stability as bunkers are consumed.

Grain stability calculation forms: The governments of a number of the major grain exporting countries require the master to show that the ship will at all stages of the voyage have sufficient stability to satisfy the Grain Rules. This requirement is normally satisfied by completing the required calculations, and entering the results in a form provided by the government concerned.

Copies of the forms provided by the United States, completed for a loading undertaken by the *Regina Oldendorff,* are at Appendix 19.5, accompanied by explanations of some of their more useful and more confusing features. The forms provided by different countries are all intended to obtain the same information, but differ in the detail of their designs.

Trimmed and untrimmed ends: As noted above, a ship which has been issued with a dispensation from trimming ends is not required to have the ends of her holds trimmed full. The advantage of this option is that if trimming is avoided the time and the cost of loading is substantially reduced.

Two disadvantages may be suffered as the result of leaving the ends untrimmed. The ship's stability will be reduced although, provided that the minimum requirements are still satisfied, this need cause no problems. In addition, the volume of grain which can be carried is reduced by the space remaining in the unfilled ends. This may not matter when heavier grain (e.g., grain with a SF of 42-47 cuft/tonne) is being carried, since it is likely that the ship will be loaded to her marks before all spaces have been filled.

Normally the decision as to whether ends are to be trimmed or not will be made by charterers or shippers, who will have chosen a ship which is able to comply with their requirements. If a master is required to compare the two alternatives (with ends trimmed or untrimmed) for a particular loading it will be necessary to make full calculations for each alternative, since the results may have unforeseen consequences in marginal cases. For example, it may be found to be necessary to leave a different hold slack to achieve the desired trim.

The stowage factor will affect the number and positions of the compartments to be filled and this in turn, in conjunction with the bunkers to be carried and the limiting draft, will affect the deadweight and the stability, which may dictate revision of the first assumptions as to the quantity and position of the cargo to be carried. The ship with untrimmed ends will normally load faster and more cheaply. With ends trimmed and all cargo spaces filled she will load more cargo.

Regina *Oldendorff* with grain from Three Rivers to Oran: There are several points of interest in the voyage of the *Regiona Oldendorff from* Three Rivers to Oran, featured in the grain stability calculation forms (Appendix 19.5).

If all holds had been loaded with untrimmed ends the ship's stability would have been insufficient, with grain heeling moments of 14,678 mt.m compared with maximum allowable heeling moments of 11,433 mt.m. Calculations showed that adequate stability could be achieved by trimming the ends of only two holds, thus keeping the additional cost of trimming to a minimum.

The limiting draft for the berth in Oran was 9.8 m, but the arrival draft for the *Regina Oldendorff* at Oran was 10.3 m before deballasting. However, once she had arrived within port limits complete discharge of ballast from 3 & 4 DB tanks would produce a draft for berthing of 9.8 metres, even keel. The consequent reduction of her positive stability within port limits would be acceptable.

Carriage of grain in topside tanks: Some bulk carriers, such as the *Regina Oldendorff,* are equipped for the carriage of grain in the topside tanks. Loading is done by pneumatic or mechanical hose through manhole lids set in the main deck. Each topside tank is connected to the adjacent hold by feeder ports, or dumping manholes, at the base of the tank (Fig. 1.32). These must be left open whilst grain is carried allowing grain to flow through into the hold as the cargo settles and during discharge. In practice the option of loading in the topside tanks is rarely used though it may be found necessary when the ship is required to load a precise amount of cargo and cannot comply with the Grain Regulations when using the main holds only, or when several grades or types of grain are to be carried. It is not necessary to use the topside tanks when the cubic capacity required is restricted by the high density (low stowage factor) of the cargo or by draft restrictions, and it is not a practical option when loading is to be by grab.

Even when the carriage of grain in the topside tanks is possible it will be viewed with caution because of the practical difficulties. The preparation of the tanks for cargo, when they are normally used for water ballast, is likely to require substantial time and effort from the crew in addition to the routine preparation of the holds. The tanks must be scrupulously cleaned, the feeder ports must be unbolted and the ballast line must be blanked off. Loading grain into the tanks normally presents no problems, but the flow of grain through the feeder openings at the time of discharge is often not as free as is intended, and this slows the process.

Some charterparties state that all extra costs incurred as a result of carrying grain in topside tanks are to be met by owners; this is another factor which discourages their use.

The topside tanks of the *Regina Oldendorff* have been designed for efficient cleaning, and discharge of grain. The ship's side framing (Fig. 19.1) runs horizontally and is canted so that grain will slip from its surface. The underdeck framing (running fore and aft) is without flanges which would catch dirt or cargo residue, and the hopper side framing (running fore and aft) is in the hold and not within the tank. Each topside tank is partly subdivided along its length by transverse web frames (Fig. 19.2) usually occurring at intervals of four frame spaces. The loading manholes are situated so that every bay can be reached from a manhole by passing through no more than one web frame.

Most of the features mentioned above will help to minimise the amount of cargo which remains in the tank after the contents have fed into the hold by gravity during the main discharge. It is certain, however, that some cargo residues will remain, mostly at the base of the tank, from whence they will have to be removed by hand before discharge is complete and the tank can be ballasted.

The topside tanks must be isolated from the ballast system before grain is loaded in them to ensure that ballast cannot be accidentally flooded into the tanks, and they must be reconnected to the ballast system when the tanks have been emptied and cleaned. The system for isolating the tanks-for example, the fitting of blanks in the ballast lines or plates over the ballast suctions-should be freed and overhauled occasionally even if the tanks are never used for grain, to ensure that it can still be used if required.

When grain is to be carried in topside tanks the tank bilge suctions must be connected up and the cover plates must be sealed with hessian, ensuring a cover which is graintight but not watertight. Serviceable sounding pipes must be available so that the tanks can be sounded daily.

Hold preparation: Maximum ventilation of grain cargoes is required and where a ship is provided with portable ventilators for fitting to the hatch covers these should be bolted in position before the prelpading survey, provided that when they are in position they do not prevent the opening of the hatches.

Hold cleanliness: Procedures for cleaning holds have been described in detail in Chapter 5. When grain is to be carried the hatch covers, holds and bilges must be absolutely clean, dry and free of taint and infestation. A ship can reasonably be rejected for grain loading when the cargo spaces are not absolutely clean, since the cargo is for human or animal consumption and must be protected from contamination. In addition it has often been suggested that when no cargo is ready for loading, the surveyors may inspect the ship with even greater care than is normal looking for any excuse to reject her and thereby to prevent laytime from commencing. It is the ship's responsibility to ensure that surveyors have no valid reason for rejecting the vessel.

All traces of previous cargoes and of loose scale must be removed from hatch covers, coamings, beam flanges, frames, brackets, casings, manhole covers and bilge wells. Bilge wells should be readily accessible for preloading inspection and for testing of bilge suctions if required by the surveyor.

Any trace of infestation by insects must be found and removed. Such infestation is most likely behind loose scale and within recesses such as bilge wells and manhole cover recesses. Infestation may be removed with a suitable grain-compatible spray or by fumigation, and expert advice should be requested through the owners for anything more than a minor localised infestation.

After they have been placed in good order the cargo spaces should be reinspected by the master or chief mate a few hours before the preloading inspection to ensure that all remains in perfect order for that inspection. Grain inspectors have been known to check storerooms and accommodation and can reject vessels if these spaces are found to be infested, even if the holds are acceptable. This action is justified by the possibility of the infestation spreading to the holds.

Loading of grain: Some grain silos are very large structures containing a large number of separate bins. Each bin contains a consignment of grain and the specifications of the grain may vary from one bin to another. The specification required for a particular shipment is achieved by mixing the contents of different bins in suitable proportions. This may be monitored by inspectors, who will board the ship to sample the cargo to ensure that the correct mix has been loaded. If necessary they will order changes in the mix and have been known, in extreme cases, to order a vessel to be part discharged so that the cargo could be remixed to the correct grade. The contents of a bin may be the minimum pour that the vessel can call for.

Condition of cargo: The condition of the cargo should be regularly inspected during the course of loading. Ships' officers cannot be expected to be experts in the condition of grain, but they should have no difficulty in recognising grain which is wet, sprouting, mouldy, discoloured or contaminated with rat droppings or insects, dead or alive, all these and other signs should be a warning that the grain is in poor condition. It is not possible to view all the grain which is loaded, but a good impression of its general condition can be obtained from inspecting cargo in the holds during interruptions in the loading, cargo which is spilt on deck, and cargo within the hatch coaming during the final stages of loading each hold. In addition, it may be possible to inspect grain ashore before it is loaded if the method of delivery alongside allows.

Grain which appears to be unfit for shipment should be rejected altogether and should charterers insist upon the shipment a survey should be held by surveyors acting on behalf of the owners and protest should be promptly noted.[49]

Damage from leakage: Leakage of water into grain is a frequent and serious cause of claims, since any wetting of the grain will damage it. Every effort must be made to ensure that hatch covers and access hatches are absolutely watertight (a subject fully discussed in Chapter 4). When hatch covers are inspected, surveyed and/or tested for watertightness before the start of the voyage, that fact and the results should be recorded in the deck log book.

When grain cargoes suffer from leakage through the hatch covers the master is sometimes criticised if he did not seal the hatches with bitumastic sealing tape. However (as was noted in Chapter 4 where the subject is fully discussed), its effectiveness is doubtful and the damage which it can cause to the hatch covers in the long term is substantial.

Ventilation: Grain cargoes should be ventilated to the greatest extent possible, to prevent condensation and to remove heat, but there are practical problems in achieving effective ventilation. At the commencement of the voyage the only void spaces in the full holds will be beneath the deckhead at the hold ends and below the hatch covers. These three spaces will not be connected, but will be separated by the hatch coamings, which penetrate the surface of the grain (Fig. 15.2). The hold ends can be ventilated by way of the hold ventilators. The hatch square can only be ventilated by way of ventilators set into the hatch coamings or hatch covers, where such are fitted. In each case the ventilation will be surface ventilation only. Mechanical ventilation can only be used if vent fans are situated in the ventilators at both ends of the hold since, as already explained, the two ends will be isolated from one another. During the course of an ocean voyage a cargo of grain will settle, perhaps by 5-6 per cent[49] but even this is not likely to be sufficient to permit continuous ventilation along the length of the hold from end to end.

When grain was carried in tramp ships with wooden hatch covers the possibility existed of lifting the side hatches each day in fair weather to ventilate the hatch square. Aboard bulk carriers with steel hatch covers this is no longer a practical proposition, because of the danger of damage to the hatch covers as a consequence of ship's movement caused by rising swell or course alteration and because of the risk of failing to close the covers faultlessly, day after day. As a consequence, when hatch coaming or hatch cover vents are not provided the hatch square cannot be ventilated.

Ventilation of grain cargoes should be continuous, except when the external air (the ambient air) is wetter than the air in the holds, or when spray is being shipped in the vicinity of the ventilator intakes. (For a fuller discussion of ventilation, see Chapter 15.)

Infestation: Grain is liable to infestation by insects and the cargo should be inspected with care at every opportunity for any signs of insects or larvae. To emphasise this point, the sad story can be told of the handy-sized bulk carrier which loaded a cargo of yellow corn in Jugoslavia for a North African port. Loading was intermittent and took 18 days. It is probable that insect infestation was present at this time, but it was not noticed. The sea voyage to North Africa took four days and on arrival the vessel anchored to await a berth. Hatches were opened on arrival at the anchorage to inspect the cargo and some infestation was noted.

Unfortunately, the master took no effective action to deal with the problem, perhaps hoping that the vessel would berth at an early date. Instead she remained a month at anchor and when she eventually berthed the entire surface of the cargo in all holds was covered to a depth of 30 mm with infestation. The full cargo was rejected and eventually sold for one-tenth of its original value and the ship was off hire for months whilst matters were resolved.

As soon as the infestation was noted the master should have informed the owners and charterers so that expert advice could be obtained on the best way of treating the problem. It is unlikely that the ship had the resources to fumigate the cargo, but suitable materials could have been delivered to her at the anchorage to deal with the infestation.

The IMO *Bulk Carrier Code*[22] recommends that fumigation in-transit should be performed in accordance with the latest version of the IMO *Recommendations on the Safe Use of Pesticides in Ships* and that a copy of the recommendations should be aboard ship for use by ship's personnel when in-transit fumigation is taking place. (Fumigation is discussed in Chapter 21.)

On occasions a significant quantity of water may be added to a cargo of grain when mixed with a fumigant to dilute it. In one instance a shipper in the USA quoted a figure of 75 mt of water for 45,000 mt of grain.

Heating: Grain can suffer from heating, particularly if damp. It is not normal practice to take daily temperatures of grain cargoes, but it is prudent to take temperatures from time to time, particularly for grain close to the engineroom or to heated fuel oil tanks.

Cargo inspections: A prudent master will seek opportunities to inspect the cargo within the hatch coamings from a position on deck from time to time, when it is safe to do so. Suitable opportunities for opening the hatches may occur during a mid-voyage canal transit or whilst at the anchorage or in the approaches to the berth at the discharge port. Such an inspection can give the earliest warning of problems with leakage or infestation and provide an opportunity to minimise the damage.

It is important to ensure that any loose water is removed from the hatch covers before they are opened. If it is allowed to fall on to the surface of the cargo it will damage the cargo and give the misleading impression that leakage has occurred.

Discharge of grain cargoes: Discharge is likely to be by suction unloader or possibly by grab. Vacuvators (described in Chapter 16) are often used in developing areas or berths which do not normally handle bulk cargoes.

Hold cleaning after grain cargoes: When the discharging programme allows it, the thorough cleaning of the holds can be assisted by sending crew members into the holds in the early stages of the discharge. Whilst standing in the cargo they can sweep residues of grain from beam and bracket flanges which are difficult to reach once the hold is empty.

Other precautions: Dust fires and explosions have been known to occur when working grain cargoes. Smoking should not be allowed on deck whilst grain is being worked.

Carriage of coal

The total annual worldwide production of black and brown coals in 1990 is estimated to have been 6.1 billion tonnes[54], of which some 340 million tonnes (about 5 per cent) entered world seaborne trade, the major producers for export being Australia, the USA, South Africa, Canada and Poland, in that order, and the main consumers of imported coal being Europe and Japan[53].

Coal is carried in bulk carriers of all sizes, from Cape-sized vessels trading between deep-water berths at loading ports in Australia, South Africa and Canada and discharging ports in Europe and Japan, to mini-bulkers transporting small parcels between European shallow-draft ports where comparatively small tonnages of coal are required. Since the USA has no deep-draft ports able to accept fully-laden Cape-sized vessels the coal exported from the USA is mainly carried in Panamax-sized vessels, or part-laden Cape-sized vessels, although P&O Bulk shipping run vessels specifically built for the USA East Coast (Hampton Roads) to Europe trade. These vessels have a summer dwt of 115,000 at a draft of 14.5 metres, the limiting draft for Hampton Roads.

Within European waters there is a substantial trade for smaller vessels carrying transhipped cargoes of coal from north west Continental ports.

Economists distinguish two main types of coal which enter international seaborne trade-namely steam or thermal coal which is used for power generation, for industry (including cement making) and for domestic heating; and coking or metallurgical coal, used for steel production. Coal destined for a power station is likely to be steam coal, whilst coking coal will usually be consigned to a steel works.

Marine transportation of coal-the hazards: A number of hazards are associated with the carriage of coal. It can produce explosions, go on fire, corrode the ship's structure, poison or smother those who breathe its gases, and liquefy, causing the cargo to shift and the ship to become unstable and capsize.

Coal may release methane and hydrogen, both of which are flammable gases which can make an explosive mixture with air. Some coals are liable to spontaneous heating, which can cause fire, and may when heated emit flammable gases including carbon monoxide, which is also toxic. If coal is subject to oxidation within a cargo compartment the oxygen will be depleted and carbon dioxide will increase, creating an atmosphere in which breathing is impossible. The sulphur in coal when combined with moisture can produce sulphuric acid, which is liable to corrode the ship's structure. Some coals like some other cargoes composed of small particles can liquefy and shift when the moisture content is above that of the transportable moisture limit.

The *Code of Safe Practice for Solid Bulk Cargoes*[22] lays down detailed procedures for the safe carriage of coal and these should be followed with care by all engaged in the transportation of coal by sea if the tragic and unnecessary loss of lives which has in the past been associated with this trade is to be ended.

The relevant provisions of the code are summarised below *in italics* for the benefit of those who merely require an overview, but it cannot be stated too emphatically that shipmasters engaged in carrying coal should be familiar with the detailed recommendations of the code. Roman type has been used for explanatory remarks and comments.

All coal cargoes:

Before loading

- *Coal must be separated from other IMO categories of hazardous cargo, and must not be stowed adjacent to hot areas.* See the Code for details of which commodities may not be stowed near coal.
- *The shipper should provide the master with a written cargo declaration, before commencement of loading, of the cargo's contracted moisture content, sulphur content and size, and whether it may be liable to emit methane, or to self-heat, and should provide more information if possible.* The Declaration by Shipper form (Appendix 14.10) fulfils this requirement. High sulphur content of coal has been associated with heavy corrosion of the ship's structure. One shipowner considers coal to be potentially harmful when the following values are exceeded: moisture 10.0 per cent; sulphur 1.5 per cent; volatile matter 35.0 per cent; temperature 8°C. This is a matter on which the Code offers no guidance.
- *The master should ensure he receives the written cargo declaration.* Masters should bear in mind the possibility that inaccurate information will be supplied, as has happened on occasions in the past. Furthermore, steam coal shipments are sometimes created with a blend of coals from several different sources. If the different coals have not been properly mixed the characteristics of a particular part of the cargo may be very different from those stated in the shipper's declaration.
- *Holds and bilge wells should be thoroughly cleaned, and any cargo battens removed* to prevent the formation of air pockets in the cargo, *before loading commences.*
- *Coal cargoes having a moisture content in excess of the transportable moisture limit must never be carried.* A high moisture content increases the danger of cargo shifting, self-heating, and creating corrosive sulphuric acid. Loading should be stopped and hatches closed during heavy rain[37]. If shippers insist on continuing to load in heavy rain they should be issued with a letter holding them responsible for any resulting damage to ship or cargo.
- Shipment of coal from US Gulf ports, particularly in the summer months, was reported[56] in 1991 to continue to give special problems when coal was loaded directly from barges. It is recommended that temperatures of the coal in barges be obtained prior to shipment. It has been suggested[57] problems arise with coal transported in barges because water is retained in the cargo and cannot drain off, the peaked stow of coal in the barge gives high exposure to oxygen and, in addition, steam coal loaded in New Orleans may be a mixture of several grades, some of which are low grades which are particularly liable to self-heating.
- One independent consultant[5'] recommends that coal should not be loaded if its temperature is higher than ambient temperature, whilst the South African Department of Transport[58] advises that South African coal should not be loaded at a temperature higher than 45°C, or ambient temperature plus 10°C, whichever is the greater, as measured immediately prior to loading.
- *An auxiliary method of testing for the possibility of excess moisture, which could lead to cargo flow is described in the Code, as follows:*

  'Half Jill a cylindrical can or similar container (0.5 litre to 1 litre capacity) with a sample of the material. Take the can in one hand and bring it down sharply to strike a hard surface such as a solid table from a height of about 0.2 m. Repeat the procedure 25 times at one or two second intervals. Examine the surface for free moisture or fluid conditions. If free moisture or a fluid condition appears, arrangements should be made to have additional laboratory tests conducted on the material before it is accepted for loading.' In other words, if this test reveals a fluid condition the cargo should be rejected unless laboratory tests show that it is safe.
- *Other cargoes containing liquids must not be stowed where they can leak into coal. Cargo spaces must be watertight to prevent leakage from the sea. It is dangerous to use water to cool coal cargoes. Liquid from any of these sources could cause the cargo to liquefy.*
- *All electrical circuits in holds and adjacent compartments must be isolated* because methane and hydrogen are explosive, and are much lighter than air, and may escape to adjacent spaces. A recommended method of isolation is by physical removal of the fuses to a safe storage, under the care of a responsible person, so that they cannot be refitted without authority.

- Ventilation trunks leading down into the body of the cargo must be sealed, but ventilation trunks providing surface ventilation must be left unsealed, and available to provide surface ventilation.
- *The ship should carry on board appropriate instruments for measuring the following without requiring entry into the cargo space: concentration in the atmosphere of methane; oxygen; carbon monoxide; pH value of cargo hold bilge samples; temperature of the cargo in the range 0-100°C.*
  These instruments should, be regularly serviced and calibrated. Ship personnel should be trained in their use. (The use and maintenance of sampling instruments is described in Chapter 22.)
- *Means should be provided for taking cargo temperatures and sampling the air over the cargo in every compartment without opening the hatch covers.* Some ships are provided with special temperature tubes similar to sounding pipes placed midships at each end of the hold. When these are provided the thermometers can be left in position at all times lowered to a level well below the surface of the cargo and withdrawn when a reading is required. Alternatively, hold bilge sounding pipes can be used. Temperatures are routinely taken once or twice daily and it is good practice to record the readings daily in the deck log book, along with methane readings, bilge soundings and tonnages of bilge water discharged.
- The air can be sampled through methane monitoring points, pipes like sounding pipes set horizontally into the hatch coaming, or through ventilators or sampling points set into the hatch covers. Temperatures obtained from sounding pipes which run down engineroom bulkheads will sometimes provide high readings which come from the machinery spaces, and not from the cargo. Where this is a possibility readings should be obtained from several positions. The South African authorities[58] state that temperature measurement of coal in stockpiles and in vessels' holds is best done using suitably calibrated pyrometers, which are easy to use and can reliably indicate temperatures within a body of coal. Mercury thermometers, they say, should not be used unless fitted with a maximum temperature indicator, and reset before use.

When carrying a coal cargo

- *Self-contained breathing apparatus must be kept available and used, when required, by trained personnel.* Well equipped ships are provided with compressors for the recharging of air bottles, allowing more training with breathing apparati.
- *Smoking and naked flames near cargo spaces should be prohibited, and suitable notices posted.* It is simplest, and most prudent, not to allow smoking forward of the accommodation.
- *Burning, cutting, chipping, welding and other sources of ignition should not be permitted near cargo spaces unless such spaces have been ventilated and tested free of methane.* Where possible these activities should be avoided forward of the accommodation.
- *The cargo should be trimmed reasonably level to the boundaries of the cargo space to prevent the formation of gas pockets, and to minimise the mixing of air with the coal.*
- The code recommends surface ventilation when the cargo is expected to emit methane or when methane is detected, but makes no recommendation regarding surface ventilation at other times. One major operator of bulk carriers instructs masters that surface ventilation is to be effected for the first three days after leaving port, after which the ventilation is to be closed and only resumed if methane levels reach 10 per cent lower explosive limit (LEL). Masters are particularly warned of the dangers of a build-up of methane gas in the holds during times of following wind and in the period immediately subsequent to any enforced shut-down of surface ventilation due to adverse weather.
- *Temperatures of the cargo should be taken, and the air over the cargo in each hold should be tested regularly,* daily unless otherwise advised, *for methane, oxygen and carbon monoxide. A full record should be kept of the readings.* Flammable and/or explosive concentrations of gases are as follows: methane 5-16 per cent; carbon monoxide 12-75 per cent; hydrogen 4-75 per cent: All these gases are lighter than air, and carbon monoxide and hydrogen are odourless. The code contains no recommended procedure for testing for hydrogen, which may be formed when coal is mixed with water.
- *When methane, carbon monoxide or heating is detected, special precautions, described below, should be adopted.* One major shipowner defines safe limits as: methane concentrations not more than 10 per cent of the lower explosive limit (LEL), and temperatures not more than 40°C.
- *Gases from the cargo should not be allowed to accumulate in enclosed spaces, such as storerooms and workshops, near holds. Such spaces should be ventilated, and regularly monitored for gas.*
- *The hold bilges should be regularly,* daily is normal, *tested for pH* (acidity). Procedures for testing the acidity of hold bilges are still being developed since this requirement is relatively new. Methods include extracting a sample of bilge water using a narrow cup or beaker attached to the end of a sounding rod or attaching the litmus paper to the sounding rod with a water-absorbing device such as a strip of surgical bandage. The best and simplest method may be to touch the litmus paper with the wet end of the sounding rod or bob once it has been brought back on deck.
- *When excessive acidity is detected the bilges should be regularly pumped dry to reduce corrosion of the tank tops and the bilge system.* The importance of these precautions is underlined by the report[5'] of one vessel, in mint condition and on her second voyage, which found 16 mm of a 21 mm hopper plate corroded away by sulphuric acid. The combination of conditions which led to the formation of strong acid were that the cargo was a highly volatile, high sulphur coal which was loaded under extremely wet conditions, due to heavy rain, subsequent self-heating of the cargo serving to aggravate the condition. A record should be kept of tonnages discharged from the bilges.
- *If the behaviour of the cargo during the voyage is different from that forecast in the shipper's cargo declaration,* for example with respect to emitting methane, or self-heating, *the master should inform the shipper, to assist the latter in providing better information in the future.* A form for this purpose has been devised (Appendix 14.11). Some owners take responsibility for passing this information to shippers, on the basis of the records provided by the ship.

If methane is forecast or detected

- *Provide surface ventilation* using natural ventilation only, since mechanical ventilation could create sparks. *On no account should air be directed into the body of the coal as this could promote self-heating.*
- *Ventilate spaces before opening hatch covers, and avoid naked lights, and the creation of sparks when opening.*
- *The cargo hold and adjacent spaces should not be entered by anyone until these spaces have been ventilated, and the atmosphere has been tested and found safe, or unless the person is wearing a compressed air breathing apparatus.*
- *Compartments adjacent to holds must be ventilated and monitored for gas, particularly before people enter them, or before equipment is energized.*

If self-heating coal is forecast or detected

- *If the shipper has advised that the cargo is liable to self heat the master may wish to seek confirmation* from his owners or other authorities *that the intended precautions and the cargo monitoring procedures for the voyage are adequate.*
- *If the cargo is liable to self-heat, or an increasing concentration of carbon monoxide is detected, or the temperature of the cargo is rising rapidly, the following additional precautions should be taken.*
- *The hatches should be closed and kept closed, and can be sealed with sealing tape for increased airtightness. Surface ventilation should be the minimum to remove gases. Forced ventilation should not be used, and no ventilation should be directed into the body of the cargo.*
- *Personnel should not enter the cargo space. If entry is critical to the safety of the ship or of life the person entering should wear a compressed air breathing apparatus, and should be properly trained.*
- *Cargo temperatures should be monitored at regular intervals.* It is not clear whether this recommendation refers to time intervals, or height intervals. The 1989 version of the Code recommends that temperatures be taken at least once daily at three evenly situated locations approximately 3 metres below the surface in each cargo space during long sea voyages.
- *If the temperature of the cargo exceeds 55°C, and the temperature, or the carbon monoxide level, is increasing rapidly a fire may be developing. The cargo space should be completely closed down and all ventilation ceased. In no circumstances should hatches be opened to inspect the cargo, since the admission of oxygen could cause a sudden flare-up of fire, making the situation much worse. The master should seek expert advice immediately and should consider making for the nearest suitable port of refuge. Water should not be used for cooling the cargo, or for fighting a coal cargo fire at sea, but may be used for cooling the boundaries of the cargo space. The use of CO_2 or inert gas, if available, should be withheld until fire is apparent.*

Before discharging a coal cargo

- *Lightly grease the hatch cover trackways before opening the hatches for the first time after a passage, to prevent sparks which could cause an explosion if pockets of gas exist in the hold.*

Detection of heating of coal cargoes: For the last 80 years the coal industry ashore has recognised that temperature monitoring of coal was an unreliable method of detecting heating, because heat does not pass easily through coal. If the overheated portion of the cargo is not close to a temperature sampling point the rise in temperature will not be detected. The coal industry ashore relies upon the monitoring of carbon monoxide levels for warning that coal is heating, and experiments were (1992) being conducted aboard ships to decide whether this method should be given greater prominence in the marine transportation of coal[76]. As noted above, the IMO *Bulk Carrier Code* warns that if the carbon monoxide level is increasing rapidly a fire may be developing.

Marine transportation of coal-routine operational matters: Despite the numerous hazards which can be met when carrying coal, the vast majority of coal cargoes are carried without serious problem. A variety of practical and commercial considerations should be borne in mind.

Stowage factor: The stowage factor of coal varies considerably, depending upon its origin, type and grade, moisture content, history prior to shipment and the characteristics of the ship. The IMO Code[22] suggests a range of 0.79-1.53 m^3/tonne (28-54 ft^3/tonne) though other authorities quote a narrower range. It so happens that the stowage factor required to fill a bulk carrier completely whilst bringing her to her summer marks normally lies between 0.95-1.30 m^s/tonne (34-46 ft^3/tonne), this being a figure which will vary according to the ship's design and also according to the bunkers required for the voyage and the actual mark to which she is permitted to load. Thus some bulkers will be full before they have loaded down to their marks, whilst others will reach their marks before all the holds have been filled. This is a matter of which full account must be taken when the loading is planned, and the master will require to be provided with a reasonably reliable stowage factor for the cargo before the planning can be completed.

Drainage of moisture: Since coal cargoes may have a moisture content of up to 15 per cent" there can be considerable opportunity for water to drain from the cargo into the bilges during the course of the voyage. In some coal trades it has been the practice never to pump bilges because it was feared that the tonnage of water pumped overboard would appear as a loss of weight of cargo. However, as noted earlier, failure to pump bilges can result in the formation of sulphuric acid in the holds and bilge spaces with consequent corrosion of the ship's structure.

When bilges are regularly pumped during an ocean voyage weight loss due to discharge of moisture from coal cargoes is said by one authority[60] to tend to be directly proportional to the level of superficial moisture at the loading point and to the length of the trip. For a high departure level of superficial moisture (10 per cent or more) and a voyage of 40 days or more, with significant climatic changes during the voyage the drainage can, it is stated, be in the order of 1 per cent of the cargo weight measured on departure. For a voyage of 15-20 days with little climatic change and a superficial moisture level on departure of 6-7 per cent, drainage of less than 0.5 per cent is predicted.

It is a recommendation of the UN Working Party on Coal[60] that ships keep a full record certified by master or officer of all bilge water pumped overboard during the loaded voyage. When bilge calibrations are available this can be achieved by taking soundings of all hold bilges before and after they are pumped. Alternatively, bilges can be pumped first to a holding tank, then discharged after the sounding of the holding tank had been obtained.

An important practical point to remember is that the cap for the bilge sounding pipe should always be removed before the bilge is pumped to ensure a flow of air into the bilge. This will ensure that pumping is not made difficult by the formation of a vacuum and will avoid the risk of unwanted through ventilation of the coal.

Part cargoes: It is quite common for vessels employed in the coal trade to load and to discharge in several ports and for several grades of coal to be carried. This arises partly because the draft restrictions in some coal ports prevent larger vessels from loading or discharging full cargoes and partly because a range of different grades can be loaded at the same port and can conveniently be transported in a single ship with a saving in cost. The relatively low density of coal makes it possible to make a voyage with a number of different combinations of holds full, with others empty, without exceeding longitudinal stress limits and without adopting unacceptable block loading arrangements.

Carriage of iron ore

World trade: The term iron ore includes all of the oxides or carbonates of iron occurring naturally.[3] In 1990 some 360 million tonnes of iron ore entered into world seaborne trade, the main exporting countries being Australia and Brazil which between them provide some 60 per cent of world seaborne trade, with India, Canada, Sweden, South Africa, Venezuela and Mauritania being other important producers.[61] Europe is the largest market for iron ore, taking 43 per cent of world seaborne trade, followed by Japan with 34 per cent and other Far Eastern countries with 14 per cent.[61]

The 1980s saw a continuing trend towards the use of larger vessels for the carriage of iron ore to benefit from the lower transportation costs achieved thereby. In 1989, 76 per cent of the iron ore entering into world seaborne trade was transported in Cape-sized vessels, VLBCs or ore carriers, whilst handy-sized and mini-bulkers shared a mere 7 per cent of the market.[61]

Iron ore cargoes: Iron ore is likely to be carried in one of four different forms:

- ROM is run of mine, which is ore of no special grade, shipped as it conies from the mine.
- **Fines** are small screenings of iron ore. They may be **sintered,** which is a fusing together of fines with coke breeze, millstone and limestone fines to make lumps, or **pelletised,** round pellets formed of very fine high grade ores.
- **Lump** is ore larger than a certain size. (Photo 19.3)
- **Concentrates** are obtained when a natural ore has undergone some form of purification by physical separation of undesirable ingredients. Concentrates are like heavy sand.

Preplanning the loading: Iron ore is a high-density cargo, with stowage factor ranging from 0.24-0.8 mVtonne. The denser grades require very little space in a hold and when occupying only the bottom of the hold iron ore cargoes lower the ship's centre of gravity and make her very stiff.

There is a variety of ways in which a ship can be damaged by high-density cargoes when badly distributed, and the following errors must be avoided: individual holds must not be overloaded (Appendix 9.2); unsuitable block loading must not be used (Appendix 9.4); excessive shear forces and bending moments must be avoided (Chapter 10).

There is a number of operational reasons why it is more efficient to carry heavy cargoes such as iron ore only in alternate holds, a system known informally as 'jump loading', and for this reason many bulk carriers have been classified as 'strengthened for heavy cargoes, (alternate) holds may be left empty'. When so classed, it is permissible to load a full deadweight cargo, using only alternate holds, normally the odd numbered ones.

The benefits of jump loading are as follows: the average height of the cargo in the ship is raised making the ship less excessively stiff; discharging time is significantly reduced because the cargo is higher in the holds, a greater proportion of the cargo can be grabbed from the holds, and there are fewer holds to be trimmed; less hold cleaning is required; it is not necessary to use ballast holds for cargo. A disadvantage of jump loading is that it reduces the opportunities for carrying a number of different parcels of iron ore. If segregated parcels or grades are to be carried it may be necessary to use additional holds, thereby introducing block loading with its associated dangers.

Jump loading results in a greater tonnage of iron ore being loaded in each of a smaller number of holds. As a result the ore rises higher up the sides of the holds, reaching the level of the ship's side frames. This makes cleaning more difficult than when the surface of the ore only meets the lower hopper sides.

One major ship operator in the Australian trade requires all holds to be used when carrying fines to lower the height of the cargo for safety reasons. It has been found that because of the nature of the ore it will not run or 'avalanche' when being dug out during discharge. As a result, high vertical faces of cargo form at the ends of the holds where the grabs cannot reach. These faces are dangerous for the trimmers, as there is the danger of the ore collapsing and burying the men.[37]

Jump loading exposes the ship to greater longitudinal stresses and higher tanktop loadings. The additional strengthening which is designed into the ship when she is built is intended to take care of the higher stresses, but there is a greater potential for damage if things go wrong. A final problem with jump loading is that the alternate holds may not have been strengthened sufficiently to contain a full cargo of iron ore when the ship is loaded to tropical marks and carrying only a small tonnage of bunkers.

Hold preparation: Holds must be clean and bilges must be clean and covered with burlap. All the routine preparations described in Chapter 5 must be completed, but no special hold preparations are required for the carriage of iron ore.

Loading and trimming: The loading of iron ore cargoes has traditionally been thought to require no special attention, apart from the basic requirements to place the right quantities in the correct places in the planned sequence, and to keep the ship upright during the process. However, the *BC Code*[2,2] lists iron ore concentrates, magnetite, sinter feed and pellet feed (all types of iron ore) as commodities which may liquefy. If shipped wet they may shift and put the ship at risk. Officers should, therefore, monitor the amount of moisture in the cargo carefully, and follow the guidance contained in the *BC Code.*

In 1992, for the first time, the authorities in some ports in Western Australia have insisted upon implementation of the *BC Code* recommendation that cargoes of iron ore concentrates be trimmed reasonably level to the boundaries of other cargo space upon completion of loading[62]. Where this cannot be done by chutes or splasher plates used with the loading spout, the trimming must be completed by a bulldozer or front-end loader lowered into the hold on top of the cargo stow.

There appears to be no obvious reason for trimming cargo level to the fore and after ends of the holds, unless this is required to avoid excessive loads on the tanktop. A ship pitches through a much smaller angle than she rolls, so cargo is less likely to shift in a fore and aft direction and it is unlikely that any harm would result from such a shift if it did take place. At the time of writing (1993) the level trimming of iron ore concentrates is not normally enforced, but it is possible that authorities will adopt this requirement.

The benefits of trimming an ore cargo to the ship's side are that it reduces the possibility of cargo shift, reduces cargo oxidation, distributes the weight better over the tanktop and improves the ship's stability and sea kindliness by winging out the weights and increasing her period of roll. The disadvantages, from the point of view of the owners and shippers, are that the procedure is costly, loading and discharging times are increased, and when the trimming is done by bulldozer or front-end loader the cargo will be compacted and more difficult to discharge.

Loaded voyage: No special precautions are required when iron ore cargoes are being carried, but three normal precautions can be emphasised. Bilges should be pumped regularly to dispose of water draining from the cargo. Bilges should be sounded regularly to detect any sign that the vessel is leaking and a hold is flooding. Holds should not be entered except when the air has been found to be safe.

Iron ores are self draining. Iron ore loaded in Port Carder, for example, may in summer be shipped with an average moisture content as high as 5 per cent[43], but excess water will drain to the bottom of the hold with about 2.5 per cent being retained in the cargo. Excess water remaining in the hold is likely to cause inconvenience during discharge, so bilges should be regularly pumped dry during the voyage.

To avoid disputes in which cargo shortage is alleged after large tonnages of water have been pumped overboard, the ship should keep a record of the tonnages of bilge water discharged. These tonnages can be calculated when the ship has bilge calibrations by recording the bilge soundings before and after pumping bilges. Alternatively, bilges can be pumped to a calibrated tank and sounded therein before discharge.

A number of bulk carriers have foundered when carrying cargoes of iron ore. The foundering may have been preceded by flooding of holds. Hold bilges should be sounded daily to detect flooding. Flooding will be distinguishable from drainage of water from the cargo by the fact that the increase in sounding will be limited to one or two holds and that it will be more rapid.

Iron ores are liable to oxidise, thus reducing the oxygen in the air. The atmosphere in the hold must be tested to ensure that it is safe before the hold is entered or compressed air breathing apparatus must be worn. There is no requirement to ventilate iron ore cargoes, and practices vary. Some masters keep ventilators closed to exclude rain and spray from the holds. Others ventilate to maintain a healthy atmosphere within the hold.

Discharging: Holds should be well ventilated before they are entered. Iron ore is usually discharged by grab, and spillage from the grabs invariably occurs. Much of the spillage will land on the deck of the bulk carrier, or on her hatch covers if they are side rolling. This damages the paintwork, though chlorinated rubber paint seems to be damaged less easily than alkyd paint. Careful crane drivers spill less cargo from the grabs, so the ship should submit a damage claim in respect of spilt cargo as soon as spillage occurs. This may encourage the drivers to take greater care!

When discharging iron ore normal precautions must be taken to ensure that a safe discharging and ballasting programme is followed and that no excessive longitudinal stresses are permitted to occur; a careful watch must be kept for stevedores' damage. The cargo calls for no exceptional precautions.

Carriage of steel

Substantial quantities of steel products enter world trade, with much of this trade being transported in handy-sized and mini-bulkers, which offer spacious, unobstructed holds with large hatch openings which are well suited to the loading, carriage and discharge of these products. An excellent detailed guide to the transportation of steel cargoes is available[63] and can be recommended to anyone required to carry steel products for the first time: these notes on the carriage of steel are largely based upon it.

Steel products and the likelihood of damage: All steel products are liable to damage from faulty handling and most are liable to damage from rust, a type of damage which can give rise to substantial claims. A claim that the commercial value of the cargo has been reduced by rust is a difficult one to disprove. As a rule of thumb it can be taken that all steel products which are wrapped—i.e., enclosed in packaging—should be considered as finished products which must be treated with great care. Any damage whatsoever will make the affected parts or even the entire item of cargo unusable for the purpose for which it was originally intended.

Cold rolled steel products can be damaged easily and will normally be wrapped in packaging which is intended to be moisture proof and to provide some protection from mishandling. Such material requires the highest standard of care. Hot rolled steel products are intended for further processing and if they are not wrapped it can be assumed that rust, when caused by contact with fresh water, is not a problem.

Substantial quantities of steel sheeting in coils (steel coils), packages and bundles, structural steel and merchant iron are transported by sea, and a number of other products such as pipes, wire rods, slabs, billets and blooms are regularly shipped.

Handling damage may occur in a number of ways. A steel coil should be perfectly circular, but if it is landed too heavily may become oval in shape. Packaging of steel may be damaged, permitting damage of the contents by contact or by rust. The overloading of slings by stevedores can lead to cargo being bent, chafed or scored. Incorrect stowage can allow cargo to be crushed, warped or bent in the stow. Mishandling of cargo causing damage can occur before shipment, and movement of cargo in the hold can cause damage during the voyage when the ship works in a seaway.

Rusting of steel cargoes can occur as a result of exposure to rain during loading or discharge; the formation of condensation (cargo sweat or ship's sweat) in the hold; or sea water leaking into the hold. Salt water is damaging to all steel and can lead to very heavy claims. No steel should be exposed to contact with sea water or to fresh water which is polluted with chemicals. Any allegations of salt water damage should be carefully checked. When cargo has been washed by a surveyor to find traces of salt a separate sealed sample of the water used for the washing should be preserved for laboratory testing if necessary.

Rain water and condensation are damaging to finished steels even when they are wrapped in moisture-proof packaging, so they should never be loaded or discharged in the rain and ventilation should be controlled to ensure that they are not exposed to sweat.

Rust which occurs on hot rolled steel as a result of rain water or condensation is unlikely to have any adverse effects over a reasonable period of time. It is acceptable to load or discharge hot rolled steel in moderate rain, but the cargo should not be allowed to stand in pools of water in the hold.

Planning the loading: As a starting point for the loading of a cargo of steel products the following points should be borne in mind, in addition to the considerations discussed in Chapter 9.

- Longitudinal stress limits (which affect the larger vessels and those strengthened for loading in alternate holds) must not be exceeded at any time.
- Maximum tanktop loadings must not be exceeded. Normally the total tonnage loaded on the tanktop presents no problems, but spot loadings may be excessive. They must be avoided by the use of sufficient dunnage to spread the load over a wider area.
- When items are loaded by crane and are to be discharged by ship's gear they must be placed in holds served by ship's gear of sufficient capacity. (Steel coils, for example, can weigh as much as 30 tonnes each, so can only be placed in a hold served by a crane or derrick of at least that capacity.)
- When products require lashing the usual approach is to lash the cargo to itself to form a single solid block of cargo. This is the method normally used for steel coils, for example. For some cargoes such as pipes and structural steel it may be necessary to use eye bolts (padeyes) welded to the ship's side and the tanktop. If not already fitted, eye bolts can only be safely welded in positions where no fuel tanks are located.
- It is more difficult to achieve a secure, tight stow of large, symmetrical items in holds such as No. 1, which does not have parallel sides. Where possible such irregular spaces should be used for smaller items of cargo.
- A block stow of cargo in the fore end of the hold is always likely to be less secure than one in the after end, because of the ship's normal stern trim. When the whole length of the hold is not to be used, a stow in the after end is to be preferred to one in the fore end.
- Problems are likely if steel products are stowed in the same hold as cargoes which contain and release moisture (hygroscopic cargoes). Cargoes such as timber contain moisture and have different ventilation requirements to those of steel products, so that there is a high probability of the steel suffering damage from cargo sweat or ship's sweat.
- When no large change in temperature is experienced during the voyage steel and timber can be successfully carried together, but such a combination should never be attempted without careful consideration.

Hold preparation: Steel is vulnerable to damage from traces of previous cargoes, particularly those which contain sulphur, such as coal, iron ore, phosphates and compound fertilisers, so holds should be carefully cleaned to remove all traces of previous cargoes. Holds which have been washed with salt water should receive a final thorough rinse with fresh water using a portable high-pressure gun to prevent ship's sweat from becoming contaminated with salt. Washing with fresh water is even better, of course, and can be achieved without massive cost if the ship visits a fresh water area such as the northern Baltic and takes the opportunity to fill a suitable tank such as the forepeak with water for washing.

When carrying steel products it is essential that hatch covers be tight to ensure that no leakage into the holds occurs. The condition of the hatch covers and their seals and fastenings should be carefully checked. If possible the hatches should be tested for watertightness by ship's staff or shore surveyors and the results should be recorded in the deck log book.

Preshipment survey: It is common in many steel trades for owners or charterers, prompted by their P&I Clubs, to appoint a local surveyor to conduct a preshipment survey of the cargo. When the ship's personnel are unfamiliar with the trade the surveyor can advise them if the cargo is in satisfactory condition and if clausing of the bills of lading is necessary.

Loading and stowage: Whilst the cargo is being loaded a careful watch must be kept for damage to cargo and to ship. Tally clerks or surveyors may be appointed to note defects to each item of cargo on behalf of the owners in the case of high value products such as steel coils, but the master and his officers must satisfy themselves that such people understand their responsibilities and that they are carrying out their duties conscientiously and recording every item of damage.

If fork-lift trucks are to be used in the hold for the positioning of heavy items such as steel coils in the stow, it will be necessary to confirm that the weight of the loaded fork-lift truck does not exceed the maximum permitted tank-top load, and that they are equipped with suitable attachments for handling coils without damage. If fork-lift trucks are to be used to work over other cargo, steel plates must be laid to protect the lower layer. This can only be done when it is certain that the lower cargo will not be damaged.

Loading must be stopped immediately, hatches must be closed, and all cargo must be covered if it rains whilst finished steels in moisture-proofed packaging are being loaded.

Dunnage is used beneath and within all cargoes of steel coils and at the ends of the holds to keep the cargo clear of the vessel's structure. When wire lashings are used it is customary and necessary to use a considerable amount of timber chocking material between the top layers of coils. On the other hand, experience has shown that when strapping bands are used for lashing and have been tensioned correctly, the use of dunnage belted in between the coils tends to upset the tensioning of the strapping bands. For this reason chocking is not used with strapping bands and this system is found to give satisfactory results.

Different steel cargoes require different securing systems. Such systems range from that required for reinforcing bars (bundles of long steel rods) which normally require no lashing, through that for steel billets (large rectangular slabs of steel) which simply require chocking with timber to secure any gaps in the top tier of billets, to that for steel coils, which require an elaborate system of chocking and lashing, reinforced with wedges (Fig. 19.4).

Chocking is the process of preventing cargo from moving by filling gaps in the stow with lengths of sawn timber set tight by wedges driven between them. Chocking is also the timber which has been used for the process of chocking. The individual pieces of timber which form the chocking should be nailed together to prevent them from falling apart and dropping out of the stow, as is possible when a ship works in a seaway.

Cargoes such as steel coils are lashed with wire ropes fastened with wire grips and set taut with lashing screws (turnbuckles). Lashing screws must be locked or lashed to prevent them from working back-becoming slack-under the effect of vibration. Alternatively, such cargoes are lashed with flat metal strapping bands which are set taut to a tension of 2,000 kg with a pneumatic tool and secured with crimped seals. This method of lashing is being used increasingly widely because of its convenience, effectiveness and cheapness but, like any other system of securing, it is only as good as the people who install it and they must be carefully supervised by the ship's officers if a secure stow is to be ensured.

The subject of securing steel cargoes is an extensive one and is comprehensively covered in the specialist book[153] upon which these notes are based. What must be emphasised is that ships carrying steel cargoes are usually very stiff and roll violently in a seaway, frequently rolling 30° or more in each direction. When the vessel reaches the end of her roll, the inertia of the cargo causes it to wrench at the lashings and chocking which secures it. In these conditions any inadequate lashing or chocking is very quickly exposed.

Steel products which break adrift in a hold can very quickly do enormous damage to surrounding cargo and to the ship. It is essential that every lashing is properly positioned, properly fastened, properly tensioned and complete. Whilst the men employed for the chocking and lashing are usually experienced they do not sail with the ship and see the outturn condition of their work and they are not infallible. Their work must be checked by the ship's officers, who should insist upon additional or repositioned chocking and lashings when required.

Care must also be taken to ensure that the lashings are in positions where they will not damage the cargo. For example, when a wire lashing passes through a steel coil and bears on the inner edge of the coil that edge should be protected by a custom-made steel plate, or by other suitable material. Such protection is not needed when steel strapping is used, as this will not damage the coil.

Cargo documents: The bills of lading for steel cargoes and the mates' receipts when issued should provide a true and accurate description of the apparent order and condition of the cargo at the time of loading. The clausing of bills of lading is a matter which can easily cause difficulties for a master who is not familiar with the steel trade and can give rise to disputes. Some ship operators with experience of the steel trade expect to advise their masters on the clausing of bills of lading and the master should consult his owners to ensure that the wording he proposes to use correctly reflects the condition that he has seen. Once the condition of the cargo has been seen and most of it has been loaded, the master can find a convenient time before completion of loading to talk to his owners. Other owners who lack special knowledge of the trade will turn to their P&I Club and the club's surveyor for advice, and he should be able to suggest appropriate clausing.

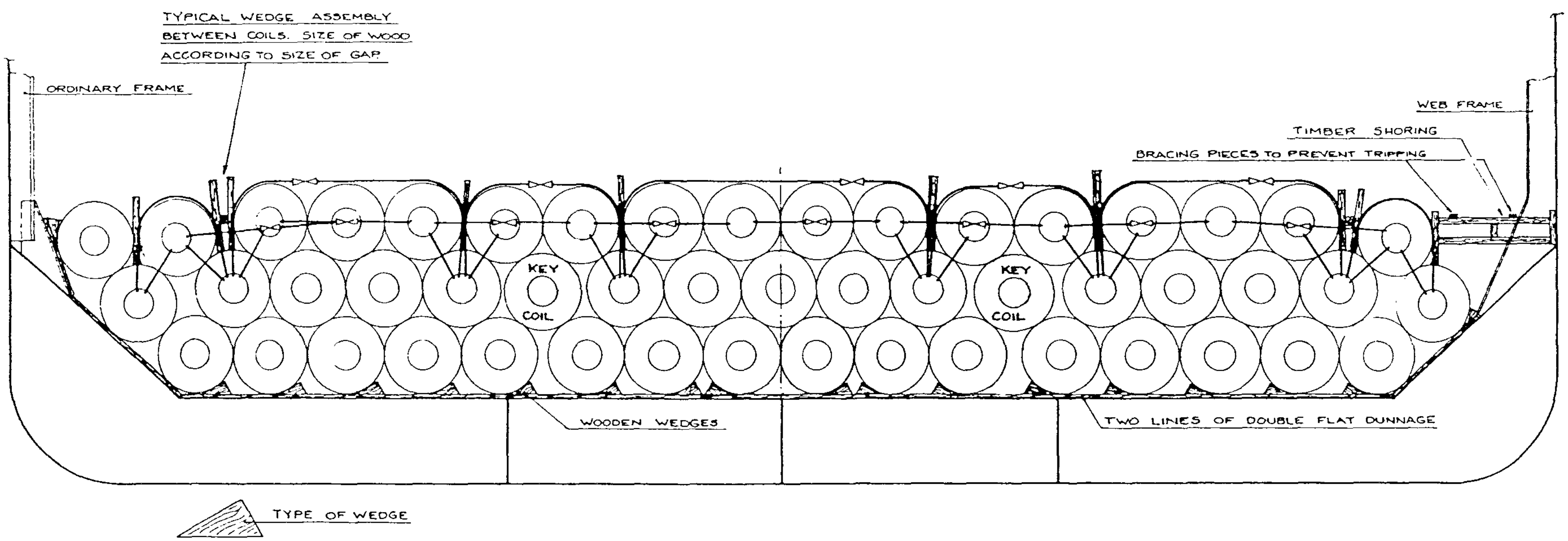
In general, the clausing should provide an accurate description of any preshipment damage, including any rusting of the cargo. Any preshipment contamination by other matter should also be noted. The clausing should be confined to a factual description of the damage, rusting, or contamination and should not attempt to say how the damage occurred or who caused it. The clausing should not use imprecise or vague terms or quantities. If the master estimates that about 75 per cent of coils are rusted, and there are 120 coils in total, he should state '90 coils heavily rust stained'.

Another suitable clause for steel coils might be: '17 coils presented for shipment each with one strap broken'. A clause suitable for steel reinforcing bars might be: '50 bundles rust stained in patches'. Clausing which criticises loading methods or describes damage done during loading serves no purpose and should not be used, since the ship is normally responsible for ensuring that the cargo is properly and carefully loaded.

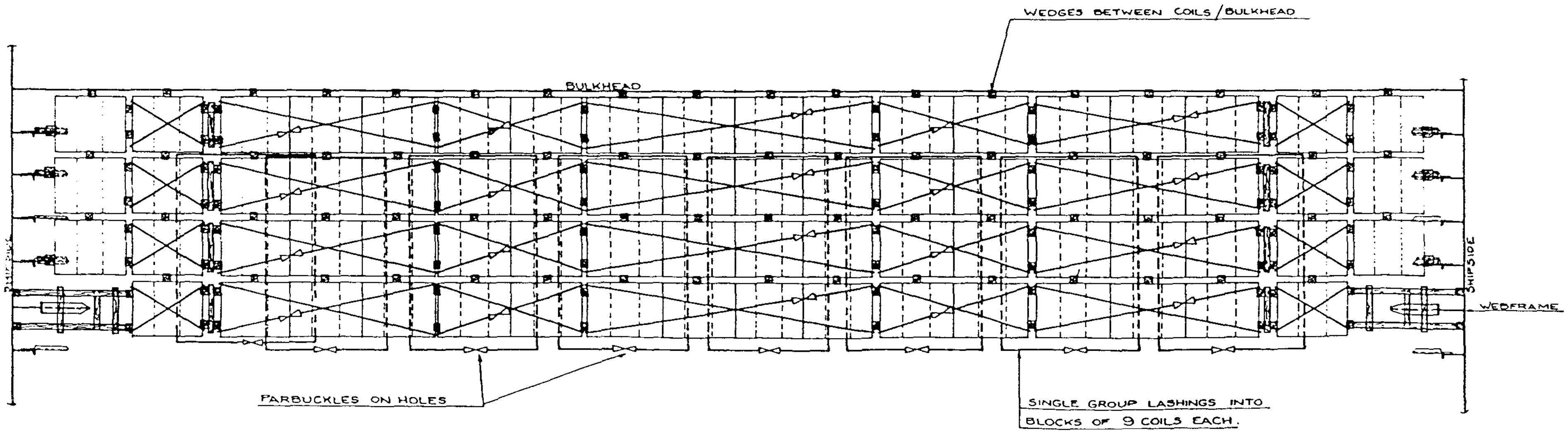
Loaded voyage-securing the cargo: During the loaded voyage, securing the cargo and its ventilation are the two matters which should particularly concern the master and his officers when carrying steel. Lashings are liable to stretch when the ship is rolling in a seaway and lashing screws under tension will slack under the effects of vibration if they have not been secured to prevent this. When lashing wires are stretched by the cargo responding to the movements of the ship, their diameter is reduced and the wire grips which fasten them become slack. Wire lashings should be inspected regularly-at least daily in rough weather-and tightened as necessary.

When the lashings are flat metal strapping bands the ship normally has no method of tightening or renewing them. If lashings are found to have stretched and become slack due to the ship's movement the only available method of resecuring the stow is to force timber between individual items of cargo.

It must be emphasised that entering the holds to inspect the lashings can be a hazardous business. It is always necessary to ensure that the atmosphere is safe and to follow the proper procedures for entering an enclosed space. No attempt should be made to approach cargo in the holds when the vessel is rolling heavily and there is any possibility of movement of the cargo. In rough weather the ship should be put on a course and speed at which she is steady before any



Forward face of stow—cross section.



Forward face of stow—plan view.

FIG 19.4 *Reproduced from* Steel Carriage by Sea, *A. Sparks MNI, by courtesy of the author* close inspection or tightening of lashings is attempted. Time lost due to such manoeuvres is fully justified, as it is necessary to ensure that the voyage is completed with minimum damage to ship and cargo.

Loaded voyage—ventilation: The primary purpose of ventilating a cargo of steel products is to prevent the formation of sweat, which is likely to cause rusting of the product, even when the latter is wrapped in moisture-resisting wrappings. The avoidance of sweat is always to be encouraged and is vitally important when finished (cold rolled) products are being carried.

Cargo sweat forms when the steel is at a lower temperature than the external air and that air is moist when admitted to the cargo compartments. If such air is allowed to come into contact with the steel the air is cooled and water droplets from the air are deposited on the surface of the steel. Cargo sweat will form when the temperature of the steel is lower than the dew point of the air which surrounds it. The temperature of a steel cargo can be measured when it is loaded by placing a thermometer amongst the packaging, hard against the cargo, and specially designed thermometers can be obtained for this purpose.

When steel is loaded in a cold climate and is then transported to tropical regions, as for example on a voyage from Korea to Europe via the Singapore Strait, the temperature of the steel will rise only very slowly in response to increasing sea and air temperatures. For so long as the temperature of the steel remains below the dew point of the external air, ventilator flaps should be closed and no ventilation should take place. The hold should be made as airtight as possible.

If the hatches are opened to load other cargo whilst the steel is at a temperature below the dew point of the external air such air will enter the hold and lead to the formation of cargo sweat. The loading of cargoes such as timber, tobacco and jute which contain moisture will result in an increase of moisture within the hold, increasing the likelihood that cargo sweat will form on the steel. If cargo sweat is to be prevented the safest rule is that moisture-laden cargoes must not be carried with steel and the hatches must be kept closed when the steel is colder than the dew point of the external air.

A voyage from a warmer to a cooler climate with the steel loaded warm and meeting cooler air should not cause the formation of cargo sweat. However, these are the circumstances in which ship's sweat can be formed. Ship's sweat is the sweat which forms on the cold steelwork of the ship when warm moist air within the hold comes in contact with it. Ship's sweat can form below the hold deckheads and drip on to the cargo, and ship's sweat which forms on the ship's sides will run down the sides and can form pools on the tanktop if the ship's trim and the alignment of the dunnage do not allow draining into the bilges.

Ship's sweat can, therefore, cause rusting and should be preented as far as possible by introducing cooler drier air into the holds. Ship's sweat can form on the ship's sides when the ship meets a cold current, even when the air temperature is high, and an officer inspecting the hold should look for signs that this is happening. Ventilation should be operated at all times except when the external air has high humidity and the dew point of the external air is higher than that of the air in the hold, or adverse weather is causing spray in the vicinity of the ventilator intakes.

Records to be maintained: Throughout every voyage in which finished steel products are carried outside temperature and dew point should be recorded in the log book every watch and cargo temperature should be recorded daily where possible. Cargo temperature can be recorded most easily by using a thermocouple connected to a distant reading thermometer situated outside the cargo space, but if this facility is not available readings with a mercury thermometer must be taken direct from the cargo. Every instance of opening and closing ventilation should be logged, as should the tightening of cargo lashings, and any damage found. When the hold is not being ventilated the access hatch should be kept shut as much as possible and times of opening should be logged. Hold bilge wells should be regularly pumped to ensure that no water is allowed to lie on the tanktops and the bilge soundings should be taken and recorded daily.

Discharge of steel cargoes: When a cargo of steel has been lashed the master may be asked to arrange for the ship's crew to remove the lashings before the vessel berths to save time and labour costs in the discharging port. When the port approaches are completely sheltered—for example, when they are well up a river or fiord—it is safe to remove the lashings in the approaches to the berth. It is never prudent to remove the lashings when a vessel is still in the open ocean. There are many ports where ships roll heavily when they reach the shallow water of the approaches, even when a flat calm has prevailed farther out to sea.

Wire lashings are removed by slackening and unshackling them. Shackles, lashing screws, wire clamps and undamaged wire will be saved for further use. The flat metal strapping bands (when this system of lashings is used) must be cut with bolt cutters or shears and cannot be re-used. The cutting of these straps is reported to have resulted in heavy personal injury claims in the United States. If this work is to be done at all by ship's staff, it must be done with care under experienced supervision.

Throughout discharge the ship's officers must be alert for damage to the ship or to items of cargo and must be prepared to insist upon less haste and greater care when that is what is required. All damage must be recorded and immediately brought to the attention of those responsible. It cannot be stressed too strongly that what may appear to be quite minor damage to the ship's officer can, particularly with finished steel products, result in thousands of dollars of claims from the receiver.

Hold cleaning after the discharge of steel cargoes: Remaining in the hold after the discharge of a steel cargo will be the dunnage wood, the timber used for chocks, and the lashing material, and it will often be the responsibility of the ship's crew to remove these materials from the hold. If these materials can be slung in rope slings or gathered into canvas savealls before discharge is complete the crane driver will often co-operate by lifting them out of the hold and placing them on deck or ashore, as required. It should be noted that many ports-particularly in the USA-will not permit the landing of dunnage as it may be contaminated.

Carriage of forest products

It is likely that some 40 million tonnes of forest products, including sawn timber, logs, plywood, woodpulp, and woodchips enter into world trade annually. Much of this cargo is carried in specialised vessels such as woodchip carriers, and in log carriers and forest product ships (both described in Chapter 18). All these vessels are handy-sized, or smaller.

Full cargoes of timber and all other forest products share certain properties. They are all relatively light and bulky cargoes which fill a ship's cargo compartments long before she is down to her marks. In order to carry the maximum cargo it is normal to carry additional cargo on deck, provided that the configuration of the ship and the nature of the cargo permit. The carriage of timber on deck is governed by the IMO code[18], which makes detailed recommendations for the stowage and lashing of the cargo, the stability of the ship, the way to handle her in heavy weather, the tending of lashings and the protection of personnel.

Other special factors are that a timber deck cargo can absorb water from rain, spray or seas, and that ice can form on the deck cargo. These factors can increase the weight being carried on deck, thereby reducing the vessel's stability. When planning the loading, provision must be made for absorption of water by the deck cargo and an allowance must be made for ice if it is to be expected.

Many ships have timber load lines allotted to them and are allowed to load to these deeper marks when carrying a timber deck cargo which satisfies the minimum requirements stated in the International Convention on Load Lines, 1966. When the cargo completely fills the well decks to the full height of the forecastle, when it is correctly secured and when the other requirements in the convention are satisfied, the vessel can load to her timber marks. The deeper loading is permitted in these circumstances because of the additional buoyancy offered by the deck cargo, which resists capsizing forces.

Cargo carried on deck, high above the vessel's centre of gravity, reduces her stability. Because of the buoyancy offered by the deck cargo, the stability criteria for vessels carrying timber deck cargoes are less severe than they are for vessels carrying most other cargoes. Despite this, to maintain the minimum stability required by the regulations it is sometimes necessary to carry less timber on deck than space permits.

The challenge for the ship's master and for his officers is to ensure that the maximum quantity of deck cargo is carried, consistent with the stability requirements. This is achieved by striking the best possible balance between carrying the maximum permitted volume of cargo on deck and improving the stability by carrying ballast and/or additional bunkers. The first step towards achieving adequate stability is to reduce free-surface effect to a minimum. Next, as much ballast should be carried as the limiting draft permits. Thirdly, extra bunkers can be carried. If that is insufficient to provide adequate stability the proposed quantity of deck cargo must be reduced.

The detailed planning of the loading of a full cargo of timber taking account of stability requirements is described in Chapter 10, whilst the characteristics of forest product ships and log carriers are discussed in Chapter 18, where the carriage of a cargo of logs is also described.

Measurement of forest products: The variety of measurements used for forest products can be confusing. The principal measurements which concern the shipmaster and his officers are the volume of the cargo, its weight and its stowage factor. Individual unit sizes may be of concern when planning the best stowage.

It is rare for the weight of a timber cargo to be known accurately before loading takes place. Approximate weights per unit volume may well be used by the shipper or charterer and will certainly be used in pre-loading calculations for stability purposes. It is essential that the weights be checked by draft survey during the course of loading. Round logs are listed by weight in some trades and notice is given of heavy units. Care should be taken in estimating stowage factors of logs from equatorial rain forests. Many such logs, such as vitex, have buttressed trunks. Logs sawn from the buttress ends have a star shaped cross-section and occupy considerably more space than conventional round logs.

Volume of cargo: Timber and logs are always measured by volume. The form of measurement varies according to the locality in which the cargo is loaded. The volume of cargo is the sum of the volumes of each individual piece of timber.

Stowage factors measure the space required in a hold or deck stow for a unit weight of timber or other forest product. Stowage factors take account of broken stowage, which is the space lost when units do not fit exactly into the space available and do not fill it completely. Stowage factors in specialised carriers with box-shaped holds will be better than in bulkers with hopper and topside tanks. The stowage factor of cargo carried on deck will be better than that of the same cargo carried below decks, because no space is lost above the cargo.

Unit sizes: These are the cargo volumes calculated from the extreme dimensions of the package.

Some examples of measurements used in the timber trade are explained below.

Volume of cargo: Different methods of measuring timber volumes are used in different trades. The following are those most commonly in use:

Board measure	Unit of volume based upon a unit of surface area at constant thickness.
FBM	The expression board measure is used on the West Coast of Canada and the United States for what is, more correctly, a board foot, 12 inches x 12 inches x 1 inch, which is the basis for all timber measurements in this trade. It should be noted that the word timber refers, in this area, to baulks (i.e., large pieces) of timber. Lumber is the term generally used for sawn wood goods.

1000FBM
MBM
MFBM
•M

One thousand feet board measure, or Mille. The volume of all shipments from the West Coast of Canada and the United States is measured in units of 1000 feet board measure. The abbreviations are interchangeable.

cbm The volume of timber measured in cubic metres. This is the most common measurement used worldwide. The cbm stated in the shipping documents generally refers to the volume of the timber in the package or unit, and not to the total space which the unit occupies. This is particularly important in the Scandinavian and Russian trades where timber is shipped in length packages (all pieces the same length), truck bundled packages (random length pieces), or a mixture of the two. Truck bundled packages will occupy some 10-15 per cent more space in the hold and on deck than length packages.

Logs are also measured in cbm. The measurement may reflect the volume of the log but the method of calculating volume varies in different trades. Many such measurements are carried out in conformity with local trade association requirements to calculate the quantity of timber which can be sawn out of the log, rather than to attempt to calculate the true volume of the log. Examples of such systems are *Hoppus measurement* and *Brereton scale.* Many shipping documents, including bills of lading, presented to the ship describe the logs as being so many M/T. This is an abbreviation for *measurement tons* and should not be confused with *metric tonnes.* Such measurement tons are based upon local practices which vary in different trades.

Standard The Petrograd standard of 165 cubic feet was, until metrication, the unit in general use of the Continent and elsewhere. It is now rarely used in Europe but still used in other trades including the East Coast Canadian trade.

Table of equivalent units of volume:

Unit	cbm	eft	FBM	Standard
1 cbm	–	35.3157	423.8	0.2141
1 eft	0.0283	–	12.0	0.0061
1000 FBM	2.3596	83.33	–	0.5050
1 Standard	4.67	165.0	1980.0	–

Stowage factors

eft/cbm Cubic feet per cubic metre-i.e., the cubic feet of space required to stow 1 cubic metre of timber. This is in general use worldwide where ships are measured in imperial measure and cargo is measured in metric units.

cbm/cbm Similar to the foregoing. Used when both the ship and the cargo are measured in metric units. For example, sawn timber 1.5 and logs 2.2 means that one cubic metre of sawn timber will stow in 1.5 cubic metres of space, whereas 2.2 cubic metres of space would be required for 1 cubic metre of logs.

cbm/tonne
eft/tonne

Cubic metres or cubic feet of space required to stow one tonne weight. Used for pulp, plywood and other manufactured products. In addition to the metric tonne, long tons and short tons (US) are still in use in some places.

cbm/MFBM
cbm/MBM
cbm/M

Cubic metres of space required to stow one thousand board feet of cargo. Used on the West Coast of Canada and US trade. Cubic feet can be used in place of cbm in ships measured in imperial units.

cft/std
cbm/std

Cubic feet or cubic metres of space required to stow one standard of cargo. In use in East Coast Canada trade and elsewhere where the standard is still used.

Packaged timber: If the ship's stability manual assumes that the timber deck cargo is composed of loose lumber compactly stowed along the full length of the deck whilst the cargo actually loaded is packaged timber, the total permitted amount of deck cargo may be reduced, because packaged timber when stowed will contain gaps in the stow, thus reducing the buoyancy of the deck cargo.

Most West Coast Canadian timber is shipped in length packages of standard cross-section of 24 x 48 inches. There is, however, a recent trend as more timber comes from inland forests to make up jumbo packs and to vary the cross section of packages to conform with the requirements of rail wagons.

Kiln-dried timber, pulp or plywood on deck: Packages of kiln-dried timber are generally wrapped in plastic or paper coverings although recent experiments with wax dipping have been carried out. Kiln-dried timber should be carried under deck. Should charterers require on-deck carriage, special insurance must be arranged. Similar insurance should be arranged if pulp or plywood is carried on deck. Such insurances are normally effected through P&I Clubs.

Woodpulp: Woodpulp is normally shipped in bales, unitised into six or eight bales per unit. Some specialised pulp is shipped in rolls which are unitised either by external strapping or by strapping through the cores. For the process of converting woodpulp into paper the pulp must be free of salt. For this reason the hatches, as always, must be watertight and where possible the holds should be rinsed with fresh water at the completion of hold cleaning, prior to loading.

Woodpulp is often loaded direct from the pulpmill, at a temperature higher than the ambient temperature. In these circumstances it is liable to produce considerable condensation (ship's sweat) which may drip off the ship's structure and stain the cargo. To prevent the formation of sweat the mechanical ventilation for the cargo hold should be run at full speed whenever the dewpoint of the external air is lower than the dewpoint of the air inside the hold.

The hold dimensions of forest product ships may be designed to accept a number of units of woodpulp exactly, with no gaps, thus making secure stowage a simple process. Unfortunately there are a number of different standard sizes for units of woodpulp and the dimensions of Canadian, Swedish and Finnish units from different suppliers are likely to vary. A vessel which is built to accommodate one standard will find that a tight stow can only be achieved with the help of dunnage when bales of another standard are carried. If the stow is not tight and the ship rolls in a seaway, the bales are liable to be seriously damaged by chafing during a North Atlantic ocean crossing. In some trades the only dunnaging which is permitted is with rubber/polythene inflatable dunnage bags. Timber is forbidden since wood splinters will interfere with the manufacturing process, and plastic sheeting is not acceptable as a separation for similar reasons.

Plywood: Plywood is shipped in bundles which vary greatly in size. The standard area is 2440 x 1220 mm but some larger and small sizes are shipped. Current practice is to unitise bundles into jumbo packs for speedier handling.

Sources

17. Tinsley, D, *Short-Sea Bulk Trades.* Fairplay Publications Ltd. 1984

18. *Code of Safe Practice for Ships Carrying Timber Deck Cargoes.* International Maritime Organization. 1991.

22. *Code of Safe Practice for Solid Bulk Cargoes.* International Maritime Organization. 1991.

37. Lynch, RJ. *Steel Industry Bulk Cargoes-A Guide for BHP Personnel.* BHP Transport Ltd. 1980.

43. *Advice to Vessels Bound for Port Cartier.* La Compagnie Miniere Quebec Cartier. 1989.

45. *The IMCO Grain Rules-Guidance Booklet.* UK Department of Trade. October 1976.

46. *IMO Grain Rules.* International Maritime Organization. 1982.

47. Peters, Hans J. The Prospects of Seaborne Bulk Trades-A Re-Assessment.' *Bulktrans '91.* CS Publications Ltd. 1991.

49. Thomas, O. O., Agnew J., Cole K. L. *Thomas' Stowage-The Properties and Stowage of Cargoes.* Brown, Son & Ferguson Ltd. 1985.

50. *Building and Civil Engineering Terms.* BS 6100: Section 4.2: 1984. British Standards Institution.

53. Rogers, P., Strange, J., Studd, B. *Coal Carriage by Sea.* Lloyd's of London Press. 1991.

54. Moor, M. 'Coal-the Major Growth Sector of the Nineties'. *Bulktrans '91.* CS Publications. 1991.

55. 'IMO Revised Schedules for Coal in the Code of Safe Practice for Solid Bulk Cargoes.' *Swedish Club News.* May 1992.

56. 'Carriage of Coal'. *UK P&I Club Circular* 11/91. Sept. 1991.

57. Berry, Dr. W. F., Goscinski, J. S. 'Heating of Coals in Transit-Problems, Causes & Solutions'. *Seaways* Jan. 1983.

58. *Code of Practice for the Safe Handling and Ocean Transport of South African Coal.* South African Department of Transport.

59. Lower-Hill, B. J. *Lloyd's Survey Handbook.* Lloyd's of London Press Ltd. 1991.

60. *Code of Uniform Standards & Procedures for the Performance of Draught Surveys of Coal Cargoes.* United Nations Economic & Social Council. Economic Commission for Europe Committee on Energy, Working Party on Coal. 1992.

61. Ellison, D. 'Iron Ore-Still the Market Heavyweight'. *Bulktrans '91.* CS Publications. 1991.

62. 'Bulker Trimming Purge'. *Lloyd's List.* 20.8.92.

63. Sparks, A. *Steel Carriage by Sea.* Lloyd's of London Press Ltd. 1988.

64. Llewellyn, T. J. *The Master's Role in Signing Bills of Lading.* Nautical Institute North East Branch. 1990.

65. *The Handling of Iron & Steel Products.* ICHCA Briefing Pamphlet No. 4. 1982.

76. Campbell, A. 'Research Project Monitors Coal Cargo Heating at Sea'. *International Bulk Journal.* June 1992.

96. *Code of Safe Practice for Cargo Stowage & Securing.* International Maritime Organization. 1992.

CHAPTER 20

UNUSUAL CARGOES AND SPECIAL TRADES

Bulk cargo separations, taking the ground in the berth, general and breakbulk cargoes, trading to cold regions

Bulk cargo separations

IN SOME TRADES there is a requirement for parcels of bulk cargo to be carried separately in the same bulk carrier hold for separate discharge. For example, separate parcels of pig iron are shipped from Vitoria, Brazil, separate parcels of minerals are shipped from Durban and Richards Bay, South Africa, and separate parcels of grain are exported from the USA. When separating these cargoes the objectives are to construct efficient separations as cheaply as possible subject to the design of the ship, the nature of the cargo and the custom of the trade.

Pig iron from Vitoria, Brazil: Consignments of pig iron are separated by vertical fencing supported on steel wire ropes stretched athwartships across the hold. Aboard a handy-sized bulker as many as three bulkheads permit the loading of four different consignments of pig iron in a single hold (Photos. 20.1 & 2). The stevedores erect the fencing, but require ship's staff or supercargo to calculate the position for each fence. The fence must be strong enough to support the weight of cargo on one side until the next parcel is loaded on the other side and must withstand accidental blows from the grab.

In general, each consignment must be allocated groundspace (i.e., tanktop area) proportional to the tonnage of cargo in the consignment, but this guideline must be modified with small consignments to ensure that the space between the fences is sufficient to provide easy access for the discharging grab. A second variation from strict proportion is required to ensure that no fence is placed too close to the hatch coaming ends, making it impossible for grabs to discharge the hold ends without damaging the fencing. The factors governing the position of the fencing are illustrated in Fig. 20.3.

In Fig. 20.3 the tanktop area XXAA may be sufficient for the intended parcel of cargo, but AA is so close to the after end of the hatch square that it would be very difficult to discharge the cargo from that area. The fence must be situated at BB, with the result that the cargo will be stowed to a lesser height in the area XXBB, or a larger parcel must be loaded in that position.

The tanktop area AABB may be large enough for a particular parcel of cargo, but it is only about 2 metres wide, which will be difficult for the discharging grab. The fences must be placed wider apart. The tanktop area XXBB is larger than the area DDYY, despite the fact that fence DD is farther from the end bulkhead than fence BB. This is because the ship is narrower at DDW in the bows than it is at XXBB at the after end of No. 1 hold.

The procedure for constructing the separation fences is as follows:

- In positions where fences are required, weld lashing lugs to lower hopper sides and frames at vertical intervals of 0.5 metres to a height of 3.0 metres. (Welding must not be done in way of fuel tanks. Welding will damage the tank coatings of adjacent double-bottom and side tanks. The charterers should be required to sign a letter of indemnity for the cost of later repairing the tank coating. The welded lugs should be primed and painted after fitting, to avoid the formation of rust.)
- Stretch loose doubled 24 mm diameter wire ropes horizontally across the hold between the lugs. Fit a turnbuckle (lashing screw) for tightening each wire rope.
- Weave 100 x 100 mm timber uprights vertically between the wires. Rest the foot of each upright on a length of 100 x 100 mm timber laid fore and aft on the tanktop. Cross the pair of wires between successive uprights. (Photo 20.4.)
- Tighten the wires with the turnbuckles until the wires hold the uprights rigid.
- Nail 150 x 30 mm planking horizontally to the uprights. (Photo 20.5.)
- Nail vertical planks at each upright and brace the fence with sloping timber supports, from the timbers laid on the tanktop beneath the foot of each upright. (Photo 20.5.)

The gratings seen on the tanktop in Photos 20.1 and 5 are placed there to prevent damage to the tanktop when the pig iron is poured into the hold by the shiploader. They are reduced to rubble during loading and discharged with the pig iron.

Parcels of base metals and minerals from South Africa: Parcels of various bulk commodities are exported from Durban and Richards Bay, the products including chrome sand, granulated chrome, charge chrome, lump chrome, three grades each of ferro manganese, silicon manganese and ferro silicon, andalusite chips, andalusite fines, titanium slag, titanium sand and copper concentrates. When the parcels are between 500 tonnes and 3,000 tonnes it is often impractical to provide separation by hold, and a number of parcels will be stowed in the same hold, separated by a process known as cocooning.

When planning the loading the following factors must be borne in mind.

- As far as possible different parcels of the same cargo or of compatible cargoes should be carried in the same hold to minimise contamination.
- When incompatible cargoes must be loaded in the same hold increased precautions, described below, must be taken.
- The last parcel loaded overlaps the earlier parcels and thus becomes the key to the stow. It must be the first cargo discharged.

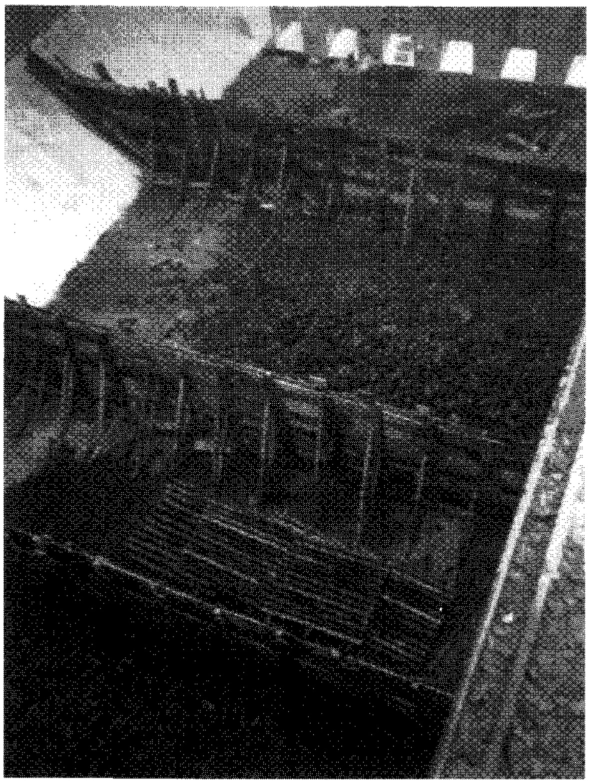


FIG 20.1 SEPARATION BULKHEADS FOR PIG IRON

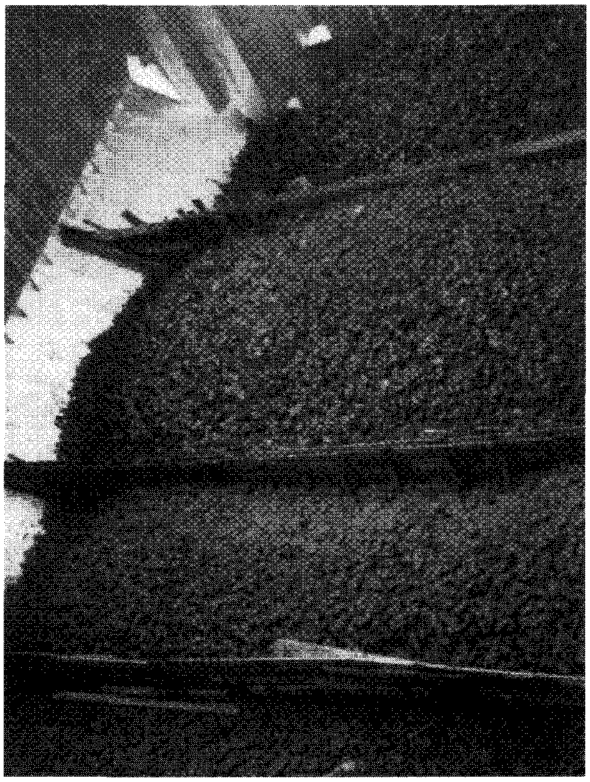


FIG 20.2 ANOTHER VIEW OF SEPARATION BULKHEADS FOR PIG IRON

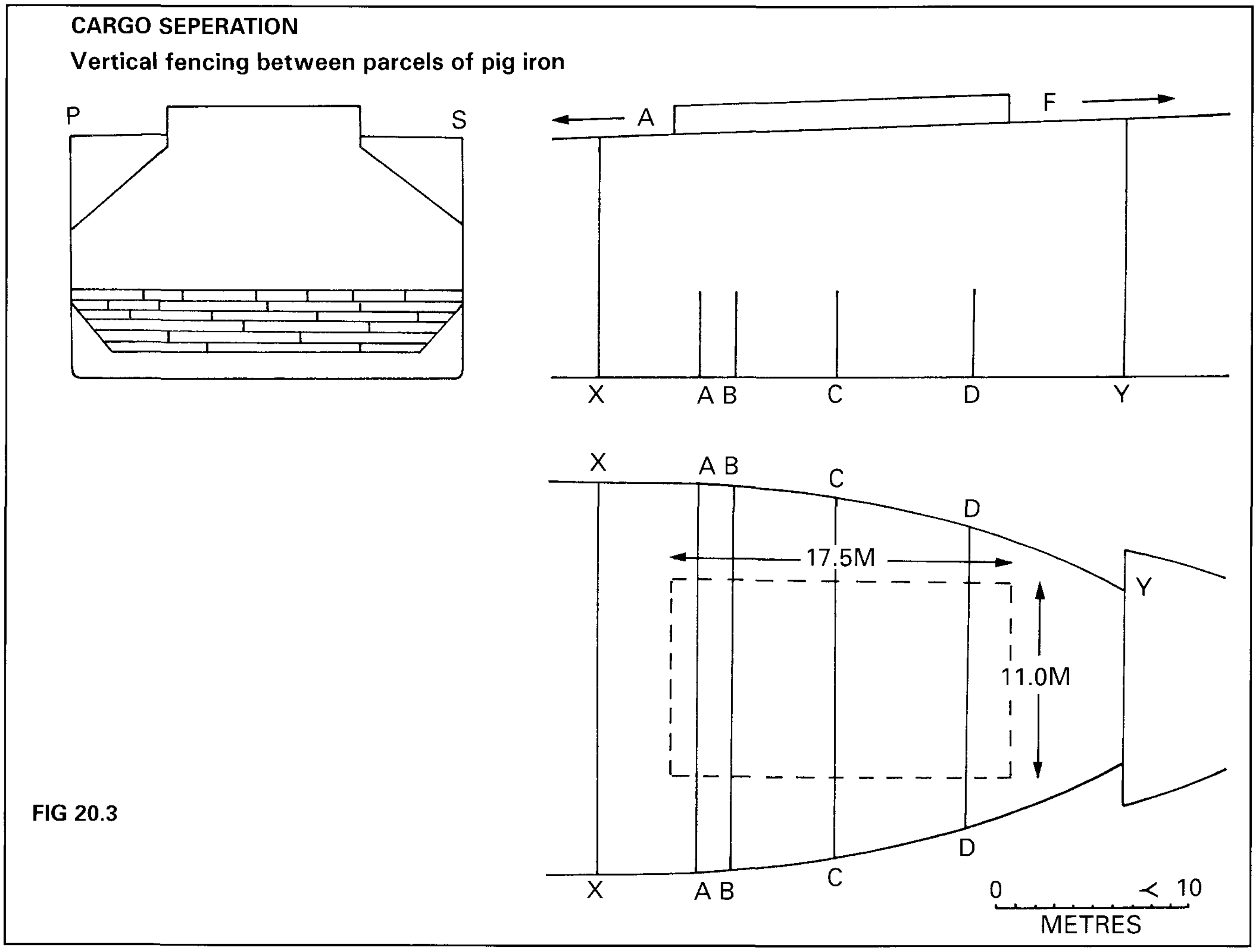


FIG 20.3

- Each parcel will overlap the previous one loaded in the same end of the hold. In general, parcels must be discharged in the reverse order to that in which they were loaded except that once the key parcel is discharged those in the fore end do not interfere with those at the after end and vice versa.
- Every parcel must have some ground space-i.e., must be in contact with an area of the tanktop-to allow the cargo to be grabbed out when discharging.

When loading commences the first parcel will be loaded at one end of the hold, where a rubber tyred loader with a long arm will be used to trim or push the cargo upwards against the bulkhead until it is stacked against the bulkhead with a sloping face corresponding to its angle of repose. (Fig. 20.6.)

Parcels of cargo are separated with hot rolled steel sheets measuring 2.4 x 1.2 metres, and with a thickness of 1.6 mm which are fitted over the surface of the cargo like a skin. The sheets are cut with oxy-acetylene torches to fit the shape of bulkhead corrugations, and to allow for ladders and pipework, and are tack welded with stitches of about 25 mm at a spacing of 300 mm. The sheets are welded in position like the tiles on the roof of a house, starting at the base of the stow. When there is no risk of contamination the cocooning will be restricted to the side of the stow where the next parcel will lie and the top of the parcel will be left open.

When the parcels are fines (commodities with small particle size), or when there is a danger of contamination between adjacent parcels, additional precautions are taken to prevent cargo from escaping from the cocoon. Plastic sheeting is placed over the parcel and taped at the boundaries before the steel sheets are put in place, and the welded joints between the steel plates are sealed with a heavy strong adhesive tape.

A parcel can be loaded at the other end of the hold following the same procedure, and thereafter successive parcels can be loaded against the previous ones until the final parcel overlaps cargo forward and abaft it. It is reported that as many as 12 parcels have been loaded in a single hold. At the time of discharge the steel plates are pulled away by cranes, and are reportedly dumped or sold for scrap.

Loading two grades of grain in the same hold: To load cornmeal and wheat, or any two grains, in the same hold the procedure is as follows:

- Load the heavier cargo (cornmeal) first.
- Spout trim the cargo as level as possible.
- Cover cargo with stout tarpaulins.
- Infill frame spaces and bulkhead corrugations with burlap or tarpaulin offcuts.
- Lay plywood sheets on top of tarpaulin.
- Cover plywood joins with overlapping plywood strips.
- Secure the plywood sheets and strips to the tarpaulin with staples, tacks or nails.
- Load the next cargo.

If discharge is by suction hose this form of separation presents no problems. If discharge is by grab the stevedores must take extra care.

Breakbulk cargo stowed over bulk cargo: To load vehicles, containers or general cargo over grain or fertiliser the procedure is as follows:

- Load and trim the cargo as above and cover with tarpaulins and burlap in the same way.
- Provide a robust flooring with extra plywood or a frame of 75 x 75 mm timber or even thin steel sheet.

Taking the ground in the berth

Most shipmasters and seamen expect their ships to remain always afloat and imagine that any grounding is cause for concern, but there are berths in many parts of the world where it is the practice of the trade for bulk carriers to take the ground in the berth at low tide.

Mini-bulkers of up to 6,000 tonnes sometimes take the ground in berths where little or no water remains at low tide. Handy-sized and Panamax vessels are required to visit berths where they take the ground during the last low water before they complete loading. The problems for the larger vessels are a less extreme version of those met by smaller vessels. For that reason, the description which follows is of a mini-bulker taking the ground in the berth.

The normal sequence of events at such berths is that the vessel berths on one high tide and grounds as the tide falls, an hour or two later. The water may leave the ship completely or, more often, a small depth of water insufficient to float the vessel may remain at low tide. She remains aground for nine or ten hours, working cargo, until the next high tide when she refloats and sails, or the cycle is repeated several more times until the vessel is ready to sail.

Taking the ground in the berth creates a number of problems for ships' personnel. Since many officers only meet such problems very occasionally there are many opportunities for mistakes to be made and it is worth considering the problems in some detail. Loading a cargo whilst aground is more complicated than discharging a cargo, and is also more common. It is that procedure which is described below.

Nature of the bottom in the berth: If the ship takes the ground in a place where there is a hard object projecting below the ship there is an obvious danger that the ship's shell plating will be heavily indented or punctured. If the berth is not plane along its full length, but contains a ridge or a hollow, the vessel could break her back. In most cases there is nothing that the master can do to guard against such possibilities. It is usually not practical or realistic to make a thorough survey of the berth before berthing, so the master must assume that there are no such faults in the berth and that the berth to which he has been ordered is safe.

He should, however, keep the possibility of damage in mind and should ensure that a full set of soundings is obtained and that any other signs are carefully considered each time that the ship refloats.

Stability and trim: Taking the bottom presents a number of unusual problems for the chief mate, who is normally responsible for the stability and trim calculations. He must ensure that the ship remains stable whilst taking the ground and he must ensure that she is able to sail at the correct draft and trim without the benefit of regular draft checks with which to monitor the progress of the loading. His calculations will be further complicated by the need for ballast water for generator cooling to be retained until the vessel finally refloats and is ready to sail.

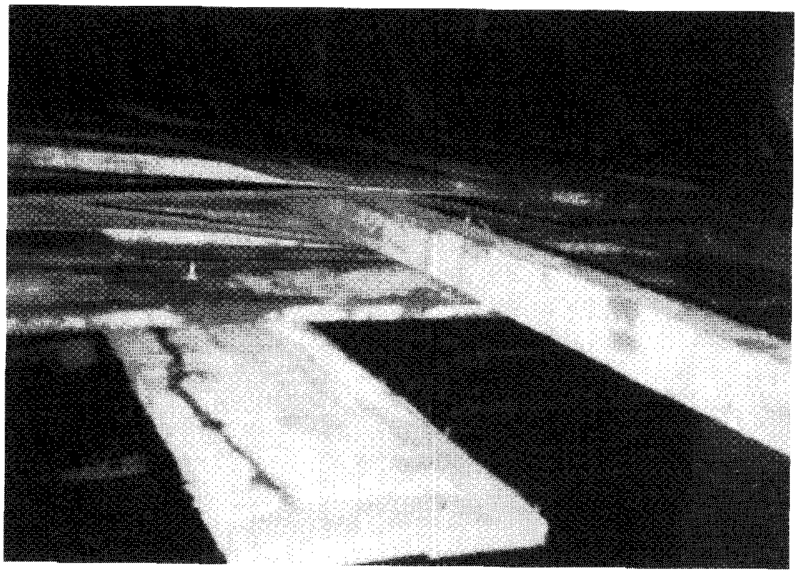


FIG 20.4 WIRES FOR SUPPORT OF UPRIGHTS

Photographs on pages 240 and 242 courtesy of CWA Consultants Ltd.

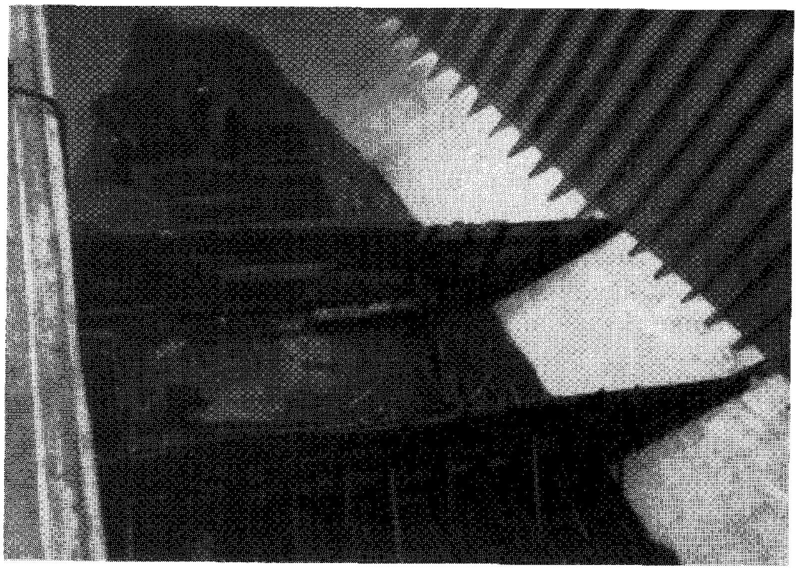


FIG 20.5 CONSTRUCTIONOF FENCES

COCOONING OF PARCELS OF ORE

NO. 4 HOLD OR BULKER LOADED IN S. AFRICA FOR CANADA

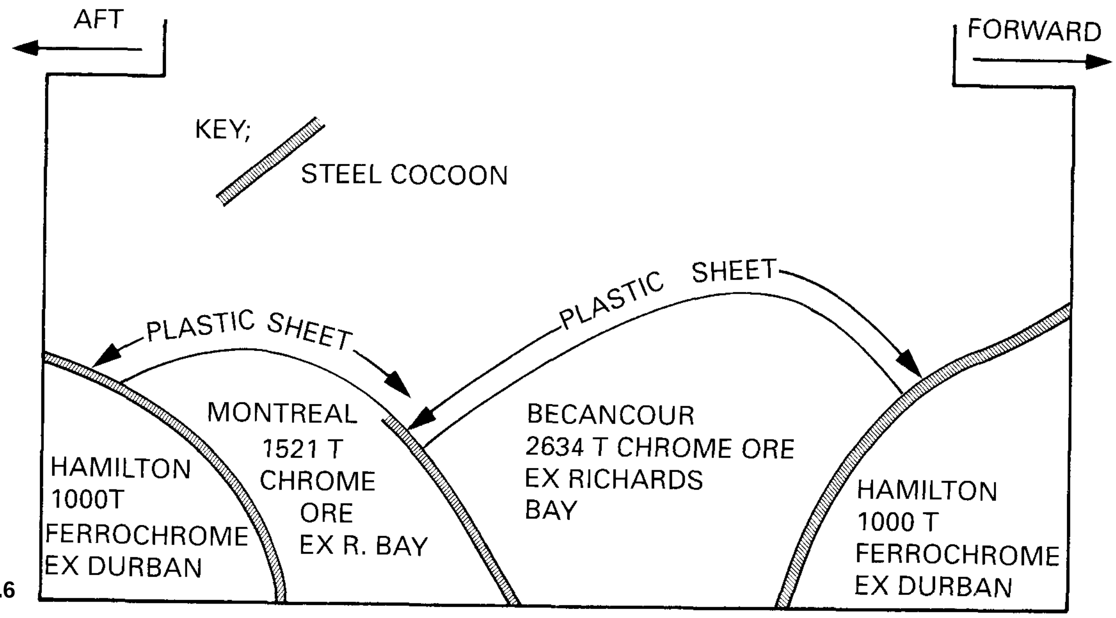


FIG 20.6

The passage from berth to sea will be undertaken on a falling tide, sometimes with draft limits imposed by the depth of water available downriver from the berth. If sailing is delayed or if the draft after ballasting is miscalculated the vessel could go aground during the downriver passage with consequences which might be disastrous.

Assuming that the ship is to load to her marks with a cargo of coal the sequence of calculations is as follows:

- Calculate the loss of stability which will occur when taking the ground on first berthing and ensure that the ship will retain enough positive stability. The calculation is the same as that for virtual loss of GM when taking the blocks in a drydock. (Appendix 20.7). Provided that the intial trim is not too great and the initial GM is large there is not likely to be any problem with stability, but if the initial trim is great or the initial GM is small the vessel may become unstable when taking the bottom. In those circumstances she will list, though it is unlikely that she will capsize. When she lists the bilge on the low side will make contact with the seabed and steady her until she takes the bottom entirely and returns to the upright, if the seabed is level.
- Decide, in consultation with the chief engineer, what quantity of ballast must be retained aboard for use in generator cooling whilst the vessel is aground. Agree which ballast tank is to be used: it will normally be the afterpeak, or a pair of wing or double bottom tanks close to the engineroom.
- Taking account of any limiting conditions and using methods described in Chapter 9 decide the draft and trim required at the commencement of the intended sea voyage. Planning should allow for the possibility that the ballast (cooling water) will be retained aboard on departure from the berth and pumped out during the passage downriver towards the sea. This is necessary because it may be possible to change to sea water cooling only shortly before sailing, allowing insufficient time to pump out the ballast before departure.
- Decide the distribution of cargo to achieve the required draft and trim. If the coal has a high stowage factor (e.g., 1.3 mVtonne) it is likely that the holds will be filled before the required tonnage can be loaded. In that case the final trim can be calculated with reasonable accuracy, and the ship will not be loaded to her marks. It may be possible to use spare lifting capacity for ballast to improve the final trim.
- If the stowage factor of the coal is lower (e.g., $0.95m^3$/tonne) space will remain in the holds on completion of loading. It should be assumed in the initial calculations that the stow will be level, so that the space will extend over the cargo for the full length of the hold. It will be important when loading to ensure that this is achieved, in order to achieve a safe stow (see Chapter 19) and to reach the planned final trim.
- Plan the loading and deballasting sequence. The only times that ballast tanks can be fully discharged and stripped will be when the vessel is afloat and trimmed by the stern, but it may be necessary to discharge the bulk of the ballast whilst the vessel is aground and approximately even keel.
- When deciding the tonnages of cargo to allow for the trimming pour there are two conflicting requirements. Because it is not possible to monitor the earlier stages of the loading by reading the drafts the tonnage allowed for trimming should be large, to ensure that the correct departure trim can be achieved. However, the time available for trimming will be limited to the short period between coming afloat and the deadline for sailing to avoid grounding in the berth or in the river on the falling tide. It will be necessary to confirm with the stevedores that the planned trimming tonnage is realistic for the time available.
- Whilst difficult to achieve, it is important that stevedores stick rigidly to the master loading plan and that an accurate tonnage for cargo loaded in each hold is known at all times.

Matters for the engineers: When a bulk carrier enters shallow water and takes the ground the ship's engineers have to deal with several unusual circumstances. Whilst in shallow water the intakes for cooling water for the main engines and for the generators may become blocked with mud or debris. High intakes will be used when the ship is equipped with them, and the engineers will hold themselves ready to change from one intake to another. If an intake becomes blocked the facility for clearing weed from the sea suction grids with compressed air will normally be used. The main engine must be shut down promptly on arrival in the berth, before the tide falls and cooling water becomes unavailable.

Arrangements will be made to use ballast water for generator cooling, with ballast water being returned to the tank from which it is drawn. This arrangement should be tested some hours or days before berthing and will be put into operation before the vessel berths, well before the tide falls and dock water is unavailable as an alternative. Whilst berthing, one generator will normally be cooled with sea water and the other with ballast water, and they will be run in parallel to minimise the problems should any failure occur in the changeover.

Since these arrangements are unusual the valve settings must be checked, and rechecked, with care. Cases have occurred in which the ballast water has been pumped out of the ship and not recirculated to the ballast tank, leaving the ship with no water to cool the generators. Instances have also occurred where cooling water has continued to return to the ballast tank after the vessel has left port, filling a ballast tank which was by that time supposed to be empty. As the time of departure approaches the engineers should be alert for the time when the water level rises sufficiently to again provide cooling water for the main engine.

The generator cooling water should again be drawn from outside the ship when the water level has risen sufficiently. When normal circulation of cooling water has been re-established, and when the vessel is again afloat, all valve settings should be carefully rechecked to ensure that they are correct, and the soundings of bunker tanks, bilges and void spaces should be checked to confirm that the ship has suffered no damage as a consequence of taking the bottom.

Period in the berth: When berthing in a berth where the vessel takes the ground it is normal for the master to ensure that the engineers are kept fully informed of each step in the programme. They should be told as soon as main engines are not required, when the tide starts to fail, when the vessel first takes the bottom and when she is aground fore and aft.

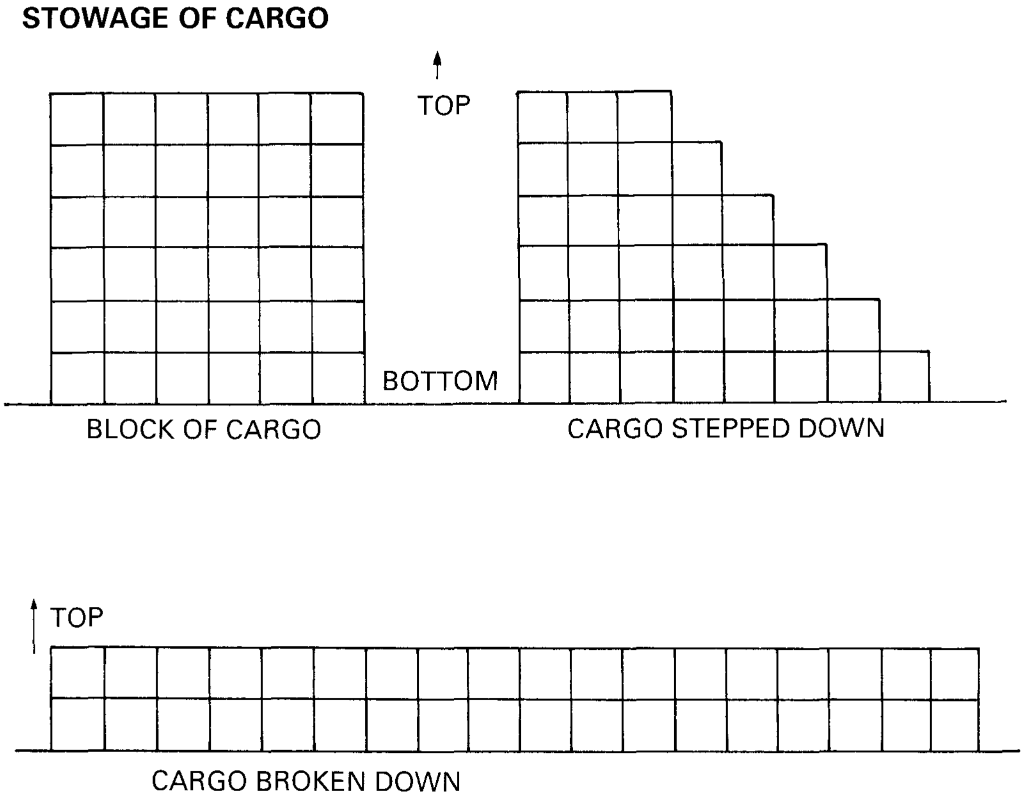
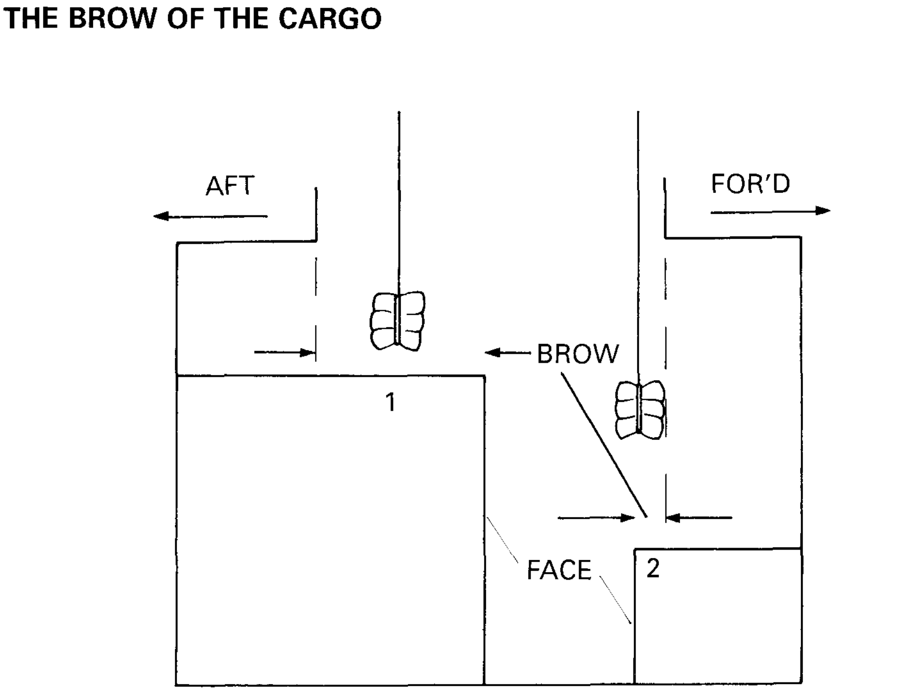


FIG 20.8



1 This brow provides sufficient room to work safely.

2 This brow is too narrow for safe work

FIG 20.9

During the full period that the vessel is in the berth the deck officers and crew must remain alert to tend the moorings and gangway as necessary. As the vessel takes the ground she may assume a slight list, and she may tend to slip away from the quay. The mooring lines must be well adjusted, all bearing an even strain to prevent the vessel from slipping away from the quay. The gangway or accommodation ladder must be properly rigged and carefully watched to ensure that it is not dislodged by an unexpected movement as the ship settles.

If the vessel lists or trims by the head when hard aground some inconvenience is likely to be suffered by the ship's company, with scuppers and drains becoming blocked. It will be impossible to obtain reliable soundings of bilges, and of ballast, fuel and fresh water tanks, and stripping of ballast tanks will be difficult. Problems of this sort must be anticipated and dealt with as necessary.

The loading of the cargo must be watched with care, particularly since ships's personnel cannot check the quantity of cargo loaded by reference to the draft readings. The method which the stevedores will use to measure the tonnages loaded must be understood and checked if possible. Ships's officers must know where cargo is to be loaded and which parts of which holds are to be left empty and must ensure that the plans are followed.

Deballasting must proceed according to the programme as far as conditions allow. If the vessel rests with a list, or without a trim by the stern, it will not be possible to discharge all the ballast according to the programme and final quantities from all tanks will remain for discharge during a period when the vessel is afloat.

If the vessel remains in the berth for the duration of several tides she will refloat at intervals. As the tide rises the engineers should be informed, and the ship's moorings and gangway should be tended as necessary to make sure that the vessel remains secure when she refloats. It is quite common for a vessel which has taken the bottom to be held to the bottom by suction when the water level rises. When she finally breaks free from the suction she often makes a sudden movement which can cause mooring lines to surge or break and disturb the means of access. When she is fully afloat a full set of soundings should be taken and inspected for warning signs, and for the progress made in deballasting.

Final refloating and departure: The final refloating and departure is likely to be an anxious time. In the space of a couple of hours it will be necessary to see the ship safely and securely afloat, re-establish normal cooling of generator and main engines, sound all tanks and spaces and investigate any unexpected soundings, complete deballasting and stripping ballast, complete the main loading of the cargo, conduct a draft survey and calculate the trimming quantities, complete the trimming pours, conduct a final draft survey, test steering gear, main engine and navigation equipment, sign the necessary cargo and other documents on completion and leave the berth in time to catch the tide.

Possible problems which can occur in these circumstances include a failure to have generators and/or main engine ready at sailing time, ship overloaded whilst aground, ship wrongly trimmed or still carrying too much ballast, or ship carrying ballast instead of cargo. In such circumstances it is necessary for the ship's master and mates to work as a team to gather and exchange information, recheck calculations, maintain contact with the engineers and implement each step in turn.

When there is insufficient depth in the berth but deeper water is available in the approaches the final draft survey and final paperwork can be completed after departure from the berth, for example at anchor in midstream.

General and breakbulk cargoes

Bulk carriers are not designed for the carriage of general cargoes, which are cargoes made up of small units of assorted raw materials and manufactured goods. When crates, cases, cartons, drums, loose machinery or casks are to be carried, often from several loading ports to several discharging ports, the most suitable ship for such products is a tweendeck vessel. Such a vessel offers two advantages over a normal bulk carrier-a tweendeck vessel possesses at least twice as much deck area (ground space) within the cargo spaces, which permits much greater flexibility in arranging the loading and discharging sequence, and the heights of the compartments in the tweendeck vessel are much lower, thus preventing stowage of cargo to an excessive height and consequent crushing.

Despite these disadvantages bulk carriers are required to carry general and breakbulk cargoes from time to time, perhaps because of the decreasing number of tweendeck vessels. In addition a charterer with unused space in his ship may sub-charter one or more holds to another shipper, who may provide such cargo. Full cargoes of rail wagons and of pallets of onions have been carried in handy-sized bulk carriers, with many bagged cargoes, and cargoes of steel products.

Basic rules for the carriage of general cargoes: The following basic rules should be observed when required to carry general or breakbulk cargo:

Planning

- Draft, trim, stress and stability at every stage in the voyage must be planned as for a bulk cargo (see Chapter 9).
- Avoid excessive local loading on the tanktop, deck or hatch covers from cargo or fork lift trucks. Use dunnage if necessary to spread loads.
- No. 1 hold, being close to the bows, is not box shaped. It is suitable for small items of cargo and bagged cargoes, but not suitable for large items of cargo. Where possible cargo for discharge by lighter at an anchorage port should not be stowed in No. 1 hold because the water alongside No. 1 hold is usually unsheltered, which will cause difficulties for the lighters.
- Bulky items of cargo such as casks of tobacco should be stowed in large holds where the loss of space due to broken stowage will be least. (Broken stowage is the unoccupied space around items of cargo.)

- Heavy items of cargo such as machinery should be stowed in the hatch square in positions where they can be landed directly and from which they can be discharged directly.

- Different cargoes can damage one another by taint, by dust and sweepings, by leakage of liquid contents, by insect infestation, by condensation from moisture content and by crushing. When stowing different cargoes together these dangers must be borne in mind.

- Hazardous cargoes should be stowed under deck or on deck in accordance with the *International Maritime Dangerous Goods (IMDG) Code.*

- Heavy cargoes for loading or discharge with ship's gear must be stowed within reach of the appropriate ship's crane or derrick.

- Cargo for each loading port and each discharging port should be shared between all holds or several holds, as far as possible, so that several gangs of stevedores can be employed simultaneously, and the total discharging time can be reduced as much as possible.

Dunnage

- Dunnage, which normally consists of softwood planks with a cross-section of 150x30 mm, or of plywood sheets, should be used with all general cargoes to protect the cargo from moisture, to provide a non-slip base for heavy items, to spread the load of concentrated weights and to bind the stow together. Beneath general cargo it is normal to place double dunnage, with the bottom layer consisting of 75 x 75 mm timber running fore and aft, to allow any water to drain to the after end of the hold, and the upper layer consisting of plywood sheets or planks running athwartships. Cargo such as cartons or sacks which could be damaged by contact with the ship's steelwork and the moisture which could collect on it, should be protected with dunnage. Layers of dunnage or single pieces or sheets of dunnage can be placed within the stow to bind it together and stabilise it.

Stowage

- When heavy and light items are stowed together the light items (e.g., cartons) must be stowed over the heavy items (e.g.,crates).

- When cargo is only stowed over part of a hold the vertical boundary of the stow is called the face. The face of the stow must be constructed with skill and care if it is not to collapse during the course of the voyage. A face which faces forward is likely to be more secure than one which faces aft, since the stern trim which is normal for most ships will tilt it slightly in the direction of security. A face in a stow of bags will normally be locked or made more secure, by stowing one tier of bags fore and aft, and the next tier athwartships. Each tier (i.e., layer) of bags is started at the face, to ensure that the bags in the face can be placed exactly as required.

Securing

- Every item of cargo must be properly secured so that it cannot move and suffer damage when the ship works in a seaway. Cargo must be secured by forming part of a solid stow, by chocking with timber chocks which secure the cargo in position, or by lashing with wire lashings or flat metal strapping bands. Cargoes of steel coils are lashed together to form a solid mass, but are not lashed to the ship. This method of lashing cannot work for items such as locomotives and heavy items of industrial or agricultural machinery. They cannot be fastened tight together and must be individually lashed to the structure of the ship. If cargoes are to be lashed to the ship's structure it is usually necessary to weld a number of lashing eye plates to the ship's tanktop, hopper sides and frames.

- A block (i.e., a stack) of cargo should never be left unsecured when a ship goes to sea. It must be chocked, or it must be broken down or stepped down. Breaking down a block of cargo means lifting down the upper items and spreading the cargo in a level stow across the tanktop, so that it is impossible for it to fall further. Breaking down and stepping down are illustrated in Fig. 20.8.

- The sloping hopper sides of the holds present problems for the stowage and securing of some general cargoes, though bagged cargoes are unaffected and cargoes such as steel reinforcing bars and girders can be stowed fore and aft across the entire breadth of the hold without difficulty. When square-sided items of cargo are to be stowed in holds with hopper sides, chocking must be used to create a series of steps.

- At various points in the foregoing notes it has been recommended that cargoes be secured with well-placed dunnage, chocking or lashing. In the sheltered waters of a port it is sometimes difficult to imagine the violence with which a ship can roll and slam in heavy seas, and to take all the precautions necessary to secure the cargo properly. Bulk carriers tend to be stiff ships, and can roll violently in a beam sea. All cargo securing should be done thoroughly and professionally using good quality materials and should be carefully inspected before it is accepted. If the master has no previous experience of the cargo and is in doubt as to the securing which is appropriate he should consult his owners and ask them to arrange for a surveyor to advise him.

Safety considerations

- Hold ladders must be maintained in good condition, and must remain accessible.

- Hatch covers, whether open or shut, must be properly secured in position.

- All openings must be guarded with handrails.

- The brow of cargo in the hatch square (Fig. 20.9) must always be wide enough to provide a safe working area.

- The brow of the cargo should be protected with lashing nets to prevent anyone from falling.

Steel products: Steel products form a special category of breakbulk cargo, and were discussed in Chapter 19.

Trading to cold regions

A number of bulk trades require ships to load, or more rarely to discharge, in cold parts of the world such as Canada, Scandinavia, Russia, Greenland and Spitzbergen, places which can be delightful in summer time, but which present real problems in winter. For general advice on navigating in ice infested regions readers are referred to The Nautical Institute's monograph *Ice Seamanship*[J0], to *The Mariner's Handbook*[31] and to Canadian Coast Guard publications[32]. The *Admiralty List of Radio Signals, Volume 3,* gives details of the ice information which is broadcast in each part of the world.

The other main problems which face the crews of ships trading to frozen areas are efficient ballasting and the operation of hatch covers, deck machinery and domestic services, arid it is these problems which are discussed in the following paragraphs. The recommendations which follow are based upon experience of bulk carriers of all sizes from mini-bulkers to Cape-sized vessels. Serious problems should be anticipated any time that air temperatures remain significantly below freezing for several days in succession, and the likelihood of problems will be greatly increased if the sea temperature is also at or below freezing. (Photo. 20.10)

Inspecting for ice damage: On arrival in port after a passage through ice it is always prudent to inspect the hull as carefully as possible for ice damage which can occur without obvious sign at the time. Such damage usually occurs near to waterline level around the bows, where the shell plating may be dished, and inspection in the forepeak at waterline level may show fractured frames. The rudder and propeller are also easily damaged, particularly when a vessel is in ballast and they are near the surface. Any inspection and its results should be recorded in the deck log book. Any damage found should be reported to the owners, who will inform the classification society and charterers.

Ballast: In freezing conditions if no special precautions are taken it is likely that airpipes, sounding pipes and ballast valves, particularly topside dump valves, will freeze up. Since these items are often inaccessible and since it may be difficult to establish what, if anything, is wrong when sounding pipes are frozen this has in the past resulted in ships sailing with unmeasured quantities of ballast sometimes weighing thousands of tonnes on Cape-sized vessels and with much less cargo than they were intended to load.

A variety of steps can be taken to minimise problems in freezing conditions.

- Any ship which is carrying fresh or brackish ballast should exchange all her ballast whilst in the open ocean for the warmest available salt water ballast (for example, from the Gulf Stream), which will not freeze so readily. If for some reason it is difficult or impossible to change all the ballast, the topside and peak tanks, which are above water level, should be changed since it is the tanks above water level which are normally most likely to freeze as a result of exposure to cold winds.
- A few tonnes of water (say, 10-15 per cent) should be pumped out of each tank to ensure that no water remains in the airpipe, where it may freeze. In double-bottom tanks which extend into the lower hopper sides (the normal arrangement) this will create very little free surface, and have very little effect upon stability. The free surface created in topside tanks by the removal of a few tonnes of ballast is likely to be much greater and should be calculated to ensure that the ship retains sufficient positive stability, although calculations normally show that this is no problem.
- As an alternative to discharging a few tonnes of ballast from each topside tank, the Canadian Coast Guard[32] recommend completely deballasting the topside tanks to ensure that they will not freeze up. This is a possibility well worth considering provided that the weather is fair and the sea is not ice infested. If the weather is foul the deeper draft will be required to reduce pounding and to reduce windage when berthing.
- If the sea is ice infested it is most important to maintain the deepest possible draft in the ballast condition in order to keep the propeller and rudder as far below the surface and below the ice as possible.
- The Canadian Coast Guard recommend that where possible 'ballast should be circulated', since movement of the ballast will inhibit the formation of ice. On most bulkers this is not possible except by filling and emptying tanks, which is not a satisfactory procedure. However, circulation of ballast is possible on some specialist cold weather traders where ballast water can be used to cool the main engine cooling water, a process which also warms the ballast water.
- As a further means of preventing the freezing of bilge and ballast sounding pipes 5 litres of antifreeze or a quantity of brine (very salt water) should be put into them during freezing conditions. Of the two salt is much cheaper, but antifreeze will cause less corrosion. The procedure for adding brine is to pour buckets of heavily salted water, containing as much salt as can be dissolved, down the sounding pipes. This should be done frequently during deballasting. (Any draft surveyor who tries to obtain samples of ballast from the sounding pipe to measure the density should be warned if salt or antifreeze has been added.)
- When deballasting, tanks should as far as possible be pumped right out in a single operation. Stripping of the final small tonnage should not be left until a later time in the loading, although this is less important with the double-bottom tanks, which are well below the surface of the water.

If, despite all precautions, it is found that ballast cannot be pumped right out and it appears that some part of the system is frozen up, efforts should be made to unfreeze the system with heat if possible. If the frozen valve, suction or pipeline is not accessible there will be no alternative but to continue the voyage with ballast retained aboard. In cases in which the vessel is sailing fully laden on her marks it will be necessary to reject some of the cargo.

If, on the other hand, the vessel is loading less than a full cargo to comply with a limiting draft at the discharging port it is worth considering the possibility of sailing at a deeper draft, with full cargo plus ballast retained aboard to be pumped out once warmer water is reached and the ballast system unfreezes. There is sometimes an advantage in sailing at a deeper draft with ballast retained aboard-the rudder and propeller are deeper below the surface and less likely to be damaged by ice. This can only be done when it is certain that the ballast can be pumped out when required.

When pumping ballast tanks full or empty in freezing conditions it is important to ensure that the airpipes are clear and that air is flowing through them. Ballast tanks have been ruptured when pumped at a time when their airpipes were blocked with ice.

Deck machinery: Before reaching freezing weather all water should be drained from deck lines, and from anywhere where it collects unnecessarily. If drain cocks have not been provided at the lowest points in the washdeck lines and winch cooling water lines they should be fitted to permit drainage. If there is any danger that the deck hydraulic systems contain any water slugs in the hydraulic oil the oil should be changed.

Motors for hydraulic deck machinery for hatch covers, winches and windlass should where possible be kept running continuously to circulate hydraulic oil, unless the system has been fitted with oil of viscosity intended for arctic conditions. The motors must be inspected regularly in case of an hydraulic leak, which could spill all over the pumproom and allow the motor to seize up. Some systems such as hatch hydraulic motors may be fitted with trips which cut-out after 15 minutes' use, in which case they should be restarted regularly around the clock. Heater lamps (e.g., cargo clusters) should be placed on the hatch hydraulic reservoir tank in the forecastle. Winch and windlass controls should be set so that the machinery keeps turning, thus reducing the build-up of ice.

Controls for deck machinery should be well greased and then covered with canvas covers. The control pedestals should then be fitted with plastic containers (old Teepol containers) over the canvas, to protect them from freezing spray. Winch control pedestals which collect condensation in their bases should be drilled to allow this water to drain away. The burning of rags soaked in paraffin is a method of warming a windlass which has literally frozen up. This is not advisable near fuel tank airpipes.

Ship's cargo grabs, if carried, are liable to freeze and when frozen are difficult to restow. Spray antifreeze on the sheaves. Unship the grabs and stow them in the holds on top of the cargo where possible.

Top and slew derricks and cranes for an hour or two daily when at anchor or alongside to prevent the sheaves from icing up completely. Inspect sheaves regularly: they are cast and will crack or break if overstressed by the conditions. Ice on the runner or topping wires can force the cheeks of blocks open, making them useless and dangerous. Special grease for use in temperatures below freezing is available from manufacturers. Where possible such a product should be used to grease deck machinery before any lengthy visit to frozen areas.

Any mooring ropes or wires on reels should be covered with canvas before entering cold weather. Seamen can be provided with pickaxe handles with which to break frozen spray on canvas or lines. Mooring lines should be covered again after the ship is moored. Those mooring ropes which are stowed below decks should only be brought on deck in the approaches to the berth. All deck lights should be left switched on day and night.

Hatch covers: Before entering cold weather the hatch rubbers and compression bars can be smeared with low temperature grease to prevent them from sticking or freezing together. If a build-up of ice on hatch covers prevents the opening of the hatches it may be possible to clear the ice away with axes and picks, followed up with the application of rock salt at the cross joints. Commercial firms if called in may use industrial paraffin flame throwers to melt ice.

When hatches have been opened antifreeze should be brushed on to the hatch rubbers, and compression bars and trackways should be sprinkled with salt to prevent ice and cargo freezing thereon. This will make the cleaning of trackways easier on completion of discharge, but make sure that sensitive cargoes are not contaminated with salt. Another procedure with the same objective is to spread canvas sheeting over the hatch coaming trackways in the way of grab discharge.

Machinery spaces: On ice-classed ships the sea water for engine cooling must in freezing conditions be recirculated back to the sea suction. Heat must be kept on the main engine continuously, and the boiler must be in good working condition with plenty of spare parts available. Heaters in the steering gear compartment and hydraulic pump rooms should be left on continuously. Steam heaters should be fitted to die engine intakes to prevent slush from blocking diem.

If it becomes necessary to drain the main engine to work on it in port it must be remembered that the cooling water which is used to refill it when the work is finished will be colder than usual, so longer than usual will be required for warming through the engine before sailing.

Bunker tanks: Install a steam hose complete with couplings in each of the domestic fresh water tanks (set against the ship's side) or the windward one will freeze up. Fresh water tanks should be filled only to 90 per cent capacity. Crack open the steam lines to all heating coils in the fuel oil tanks. Drain and isolate the heating coils for any empty bunker tanks.

Navigating bridge: Radar scanners should be left running in port to prevent them from freezing. Radars have to be on standby, or running with brilliance and gain turned down, as necessary to ensure that scanners turn. Navigation lights should remain switched on day and night at sea and in port. Ship's whistles are to be heated if heaters are fitted and drained if powered by air or steam.

The standard magnetic compass should be provided with a plastic cover (a bin liner) and a canvas cover and its electric light should be left on continously. Searchlights should be provided with canvas covers to be fitted when the equipment is not in use.

Wheelhouse window washing arrangements should be drained and not used. Alternatively, they can be fitted with tape heaters, but even when these are fitted it may be found that the nozzles tend to freeze. Wheelhouse weather doors should be taped up with broad masking tape, on the basis that people will only visit the bridge wings in an emergency. Heaters in the wheelhouse should be left on continuously.

The wheelhouse windows are liable to ice up totally, a problem which can perhaps be prevented with the use of a fan heater directed on to the windows and by coating the outside of the windows with methylated spirits. The watertight seals around the edges of windows should be checked: if water gets behind a seal and freezes it can cause the window to shatter. Clear view screens should be labelled 'check that screen is free before switching on', to avoid burning out the motors. Window wiper blades should be kept clear of the windows. Icing can cause radio aerials to collapse, so personnel should wear safety helmets and avoid walking under aerials.

Firefighting and lifesaving equipment: Electrical heater lamps should be hung around the emergency fire pump and its radiator should be topped up with antifreeze. A drum of cold weather gas oil should be obtained for use in the emergency fire pump and in lifeboat engines. The lifeboat engine must be fully drained and provided with heating, for which heater lamps or a steam hose can be used. Totally enclosed lifeboats can be permanently fitted with a 1 Kw black heater connected to the ship's power supply. Drinking water tanks in the lifeboats must be emptied to 80 per cent level or can be drained completely, with drinking water in plastic jerrycans kept in the accommodation close to the boat stations.

Holds: To allow the fitting of blanks in the ballast hold before loading cargo the bilges can be 'boiled' by use of a portable steam line and coil. A vessel which reaches a loading port with ice in her holds may be able to hire large fan heaters with which to dry out the holds, provided that a crane is available, either ship's or shore's, to lift the heaters into the ship and a suitable electrical power supply is available.

Stores: Any perishable stores such as paint must be removed from masthouses and forecastle and stored within accommodation. On big ships where the quantities are large and the distances are great it may be unavoidable that paint is kept in a forward paint locker. If such a locker is heated there is a danger of igniting paint fumes and causing an explosion. In one ship the paint locker was heated with cargo clusters, permanently switched on but heating was only commenced after all paint cans had been tighdy sealed and the space had been well ventilated.

Accommodation: Accommodation heating air is to be recirculated. All accommodation doors are to be kept shut at all times. Only one door is to be used as an entrance/exit, clearly marked, with all other doors locked from the inside, but with keys prominently placed nearby. The entrance door must be kept closed except when in use, and wooden doors which fit badly can be screened with blankets.

The air heating and lights should be left switched on in spare cabins to ensure that the temperature is not allowed to fall in these areas. Any pipework or plumbing which is placed near the outside accommodation bulkheads is likely to freeze up and must be insulated or heated. Typical precautions are the following:

- Fit tape heaters to the plastic fresh water pipes in the dry stores or drain them and shut off or blank off the supply.
- Insulate the two external accommodation toilets with loft insulation. Pour brine or antifreeze into the toilet bowls. Drain all supply lines, lock toilets and label them 'out of order'.
- Provide heating for the hospital toilet and bath if they are in an exposed position.
- Instruct all ship's company to keep bathroom, shower and toilet doors shut but ventilation grilles open to circulate air over pipework.
- Keep the galley stove lit day and night.

Personnel: It is important that ship's personnel are warmly clothed when working in freezing conditions if efficient work is to be expected of them, particularly since the difficulties encountered in such conditions can sometimes call for long periods of work on exposed decks to put right problems caused by the conditions. When working in extreme cold it is advisable to stop work frequently for a short break.

Thick quilted boilersuits of a type which can be wiped clean are to be recommended for wear with thermal underwear and normal outerwear. Insulated overshoes, balaclavas and heavy-duty waterproof jackets and trousers are also to be recommended, as are inner gloves for warmth and outer gloves for protection. Such clothing is readily obtainable in good quality in Northern Europe and Canada, though prices can vary considerably from one country to another, with Canada generally reported to be cheap. Personnel should also be provided with sufficient blankets to ensure that they can sleep in comfort.

Safety on deck: To ensure that people can walk safely on deck the ship should be well equipped with rock salt to spread on deck. If the decks cannot be defrosted grit should be spread where people will walk. Boxes containing rock salt, grit or sand should be placed on deck near to gangway and to hatches. Ice and snow can fall from the bridge front dodgers. Personnel should be warned to beware of this danger.

Sources

30. Parnell, G.Q., Master Mariner. *Ice Seamanship.* The Nautical Institute. 1986.
31. *The Mariner's Handbook,* Sixth Edition. NP100. The Hydrographer of the Navy. 1989.
32. *Ice Navigation in Canadian Water.* TP5064. Canadian Coast Guard.

CHECKLIST-Requirements for visit to freezing area

The following items may be required, with quantities dependent upon the vessel's size.

- ☐ Rock salt, 25 kg bags.
- ☐ Antifreeze, 60 litre drums.
- ☐ De-icer, spray cans.
- ☐ Electric heater lamps.
- ☐ Low temperature grease, tubs, 12.5, 15.0 or 20 kg.
- ☐ Paraffin, 60 litre drums.
- ☐ Methylated spirits, 5 litre cans.
- ☐ Axes, picks, shovels.
- ☐ Air chisels.
- ☐ Canvas sheeting, square metres.
- ☐ Auxiliary boiler spare parts.
- ☐ Steam hose, with couplings.
- ☐ Tape heaters.
- ☐ Masking tape, wide.
- ☐ Fan heaters.
- ☐ Cold weather gas oil, 200 litre drums.
- ☐ Loft insulation, metres.
- ☐ Warm protective clothing.

FIG 20.10 ICE ON DECK-PASSING THE ALEUTIAN ISLANDS

Photograph courtesy I.D. Smith, MNI

CHAPTER 21

SAFETY CONSIDERATIONS

Responsibility for safety, permit to work system, entering enclosed spaces, use of pesticides, access between ship and shore, hazards from working cargo

RESPONSIBILITY for safety rests with each individual on board ship. Not only should he protect his own health and wellbeing, but should also protect the health and wellbeing of his shipmates and colleagues. Safety is part of the job and it is the duty of everyone to give careful attention to safety, as well as to complete the task in a skilful way.

The risk of death is insufficient to persuade some people of the need for safety. Officers must for economic and humanitarian reasons ensure by example, training and continuing propaganda that safety is never forgotten or ignored when operating a ship. Dismissal from the ship or an adverse report should be considered for persistent offenders against the rules of safety. Company policy on safety should be stated in a written document, frequently updated, and officers should of course have full backing from their head office when enforcing safe practices.

Safe working practices for seamen have been listed in various useful publications such as the *UK Code of Safe Working Practices for Merchant Seamen*[79], a useful publication which deals clearly and thoroughly with many aspects of marine safety. This chapter concentrates on particular hazards which are characteristic of the dry bulk trades. No attempt has been made to consider the full range of safety issues which affect all shipping.

Permit to work system

In many situations aboard ship the routine actions of one person can endanger others. Before work is started it is necessary to identify the dangers and to remove them where possible. A most useful safety procedure and a tool of the professional ship's officer is the use of the permit to work. This system obliges everyone concerned with a particular task to concentrate his mind on the work to be done and serves to involve the team in anticipating where things might go wrong. It is also a training aid, since it indicates the correct way to set about and complete various onboard tasks. This makes permits to work most useful when instructing junior officers and ratings.

The operation of the permit to work system is simple. A checklist consisting of a numbered list of questions relating to the proposed work is completed, by entering Y (yes), N (no) or NA (not applicable), or by using a tick (•) or a cross (x) against each question. The person who is to directly supervise the work will sign the permit only when he is satisfied that all questions on the checklist have been correctly answered. Only after it has been signed should the work commence. The permit should include a description of the work to be done, and should show the time when the permit expires, which should be no more than 24 hours after the issue of the permit. If there is a need for the work to continue after the permit has expired it must be renewed.

A provision which deserves to be included in every permit requires the supervisor to sign when the work is completed. He is required to sign a statement that all tools and equipment have been safely stowed away, that the area in the vicinity of the work is clean, that all means of access to the work have been secured fastened, and that the ship's watertight integrity has been restored.

Permits with suitable wording are required for a variety of different tasks. They can be written aboard ship, or the shipping company can supply them to all their ships. Permits can be produced in duplicate pads, with one copy issued to the person doing the work and a second retained by the person who issues the permit. Some procedures require a copy of the permit to be displayed at the place where the work is being done. A copy of each permit issued should be retained amongst the ship's papers for legal reasons and to demonstrate to safety inspectors that safe working systems are in operation.

One word of warning must be sounded with regard to permits to work. If they are badly written and fail to list a necessary precaution, they can be the cause of that precaution being forgotten. A space for remarks should be provided so that additional precautions can be noted, and the permit should be revised from time to time to include necessary improvements.

The UK P&I Club has estimated" that 60 per cent of all major claims are attributable to human error, whilst other authorities put the figure as high as 80 per cent. The permit to work system is intended to reduce the opportunity for human error and is used by a number of major bulk carrier operators. It deserves serious consideration from all who intend to operate safe ships.

Entering enclosed spaces

Many serious accidents, some resulting in death, occur on board bulk carriers because safe procedures are not followed when enclosed spaces are entered. Any enclosed unventilated space which can be sealed off from the outside atmosphere may be dangerous and enclosed spaces must be taken to include cargo holds, battery lockers, paint storerooms and masthouses as well as ballast, bunker and cargo tanks.

There have been numerous cases of seamen entering a cargo hold which is battened down with little or no ventilation and being overcome by lack of oxygen. Deaths have resulted. Particularly dangerous are cargoes which absorb oxygen by rusting, such as pig iron. Seamen should *never* rush down into a hold to rescue a shipmate if they see that he has been overcome. A breathing apparatus should *always* be used and safe procedures must be followed. It cannot be repeated too often that the natural instinct to give immediate help must be resisted.

Two seamen entered a mast house containing access hatches to the holds. The hatches had not been secured and methane from the coal cargo had escaped into the mast house. One of the seamen lit a cigarette. The resulting explosion killed both men. Had no cigarette been involved they could equally well have died through asphyxiation. On another occasion five stevedores entered a hold before the hatches had been opened. The cargo was yellow corn, otherwise known as maize. Much of the corn had started to germinate during the voyage removing oxygen from the atmosphere of the hold. All the stevedores died of oxygen deficiency.

Many explosions have occurred in battery lockers due to the use of naked flames from matches and cigarette lighters. Seamen who enter storerooms such as the lower forecastle store flat after stores have been left unsecured during heavy weather have suffered serious injuries as a consequence of drums of paint or other heavy items toppling on to them. The foregoing are illustrations of just some of the dangerous situations which can be met, quite unnecessarily, if correct procedures are not adopted when entering enclosed spaces.

The International Maritime Organization has produced an excellent checklist accompanied by notes on the precautions to be taken before entering enclosed spaces (Appendix 21.1). One side of the checklist card contains an explanation of possible dangers, and sound advice on correct procedures, with guidance on who should assess the risk and advice on suitable clothing and equipment. The checklist on the second side makes provision for a responsible officer and the person entering the space both to confirm that they have taken the appropriate precautions before entry.

Officers should take great care to ensure that all involved have a very clear understanding of the isntructions on the card. Bulk carriers are manned by people from many cultures and although it is desirable that all members of a ship's company should speak the same language this is often not the case. Full discussion of the information and instructions on the card should be encouraged to confirm that they have been understood and to remove the possibility that a rating is accepting an order that he does not understand or thinks it wrong to question. If the officer in charge suspects that someone does not have a full understanding of what is intended, he should not allow him to be part of the team entering the enclosed space.

Enclosed spaces should be thoroughly ventilated, using mechanical ventilation when the atmosphere is not explosive and it is safe to do so. The atmosphere should be tested for oxygen and toxic gases before anyone is allowed to enter the space and should be continuously monitored whilst crew members are within. The access to an enclosed space should be fenced off and provided with eye-catching warning notices when it has been opened but not yet proved safe for entry. Safety is just as much a part of the job as the cleaning of the tank, or the repair of a valve, or an inspection.

The tanks of larger bulk carriers are cavernous places with very big brackets, deep frames, floors and stiffeners. It can take 20 minutes to move from end to end of a large double bottom tank, and such tanks may be entered through bulkhead stools or void spaces. A human can be brain dead if deprived of oxygen for four minutes, so the chances of mounting a successful rescue operation for someone who is overcome by lack of oxygen or toxic fumes at a point in the tank remote from the entry manhole are very poor. A useful exercise for inclusion in the ship's regular safety drills is to practice a rescue from an enclosed space, followed by the appropriate first aid and medical treatment.

Safe use *of pesticides*

In recent years the authorities have become increasingly concerned at the dangers associated with the use of pesticides aboard ships. There is the possibility that edible cargoes will be contaminated by the use of pesticides and that crew members will be harmed by contact with them.

Before describing routine procedures a warning must be given. On at least one occasion ships' personnel and stevedores required treatment when they breathed fumigant laden dust from a grain cargo while it was being loaded! The ship, in a western Canadian port, had received no warning that the cargo had been fumigated before loading. The master should enquire whether the intended cargo is under fumigation or has been fumigated and should arrange for the supply of suitable masks if necessary.

Full recommendations for the use of pesticides aboard ship have been published by the IMO[67]. A copy of this publication should be held aboard ship and studied before pesticides are used. The following paragraphs indicate the areas covered by the recommendations, but it must be emphasised that pesticides can kill and should not be used except when the full instructions have been studied.

A ship may be infested by insects or by rats. Infestation by insects may exist aboard ship or may be brought aboard with the cargo. The purpose of its removal may be to satisfy the agricultural authorities in the discharge port or to ensure that the cargo remains acceptable to the receiver. Infestation can cause cargo to overheat. Infestation by rats must be eliminated in accordance with International Health Regulations. Infestation is assisted by dirt and cargo residues. Holds, accommodation, storerooms and machinery spaces should be kept very clean to remove any opportunity for infestation.

Treatment of infestation: When a minor infestation occurs in accommodation or in an empty hold and when insects are not concealed deep in crevices, the infestation can be eliminated by the use of contact insecticides. These are applied in spray or fog form and can be administered by the ship's crew using hand spray, pressurised knapsack spray or smoke bomb. Any spray must have dried before cargo can be loaded. Insecticidal lacquers which have to be painted on surfaces must not be used in cargo spaces. Acceptable contact insecticides are listed in the IMO recommendations[67].

A more serious or deep-seated infestation of cargo space or an infestation of cargo must be eliminated with the use of a fumigant. Fumigants are administered as gases or liquid sprays. The gas may be delivered in pellets which decompose during the voyage and give a slow release of gas. Fumigant gases are poisonous to humans and their use requires special equipment and skills. They should be used by specialists and not by the ship's crew. There are detailed recommendations for the use of fumigants.

The master should be provided with full written instructions in a language he can readily understand about the fumigant used. The fumigator-in-charge is responsible for evacuating the crew, posting watchmen and warning notices, injecting the fumigant, issuing respirators if required, testing the spaces to ensure they are gas free, and issuing a clearance certificate when all traces of gas and fumigant material have been removed.

In-transit fumigation: In-transit fumigation is fumigation which is commenced in port under specialist supervision, but which continues at sea with only the ship's crew aboard to supervise and control the process. It may be proposed if the ship's stay in port is not long enough for the planned fumigation, or if it is found that the fumigant gases have not completely dispersed at the planned time of completion of fumigation and the spaces have to be resealed. It is also likely to be proposed when an infested cargo such as grain is loaded and fumigation can only commence on completion of loading or when it is a term of the contract of sale.

In-transit fumigation is hazardous because of the lack of experience of the crew and the dangerous nature of fumigants, and is forbidden by some flag State administrations. Before he agrees to in-transit fumigation the master must ensure that he has the permission of the ship's flag State administration, and of the port State administration.

At least one officer and one rating are to receive training to enable them to take responsibility for ensuring safe conditions throughout the ship. They must be familiar with the characteristics and properties of the fumigant and the manufacturer's recommendations regarding methods of detection, symptoms of poisoning, relevant first aid and special medical treatment, and emergency procedures.

The crew must be briefed. The cargo spaces to be fumigated must be inspected before loading and must be certified by the specialist as gastight and satisfactory. The ship must carry gas detection equipment and instructions, at least four sets of appropriate protective equipment, instructions on disposal of remaining fumigant material, medicines and medical equipment and a copy of the latest version of the *Medical Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG).*

The fumigator-in-charge must provide a written notice of all spaces which are unsafe to enter during fumigation and must check surrounding spaces for safety. He must remain aboard until the fumigant gas reaches sufficiently high concentrations to ensure that any leak can be detected and until such leaks have been eliminated, and must then issue a written statement that these requirements have been met and that the ship's representative is fully trained in the use of the gas detection equipment provided.

Whilst satisfying the above requirements the fumigator-in-charge may be able to leave the ship before she sails or may undertake part of the voyage with the ship, but in both cases he leaves before the ship is free of fumigant gas. Whilst in-transit fumigation is taking place, warning notices should be posted, adequate stocks of gas detection and respirators (with consumables) should be maintained and spaces around the compartment being fumigated should be checked every eight hours or more often, for gas concentrations and the readings obtained should be logged.

Spaces under fumigation should never be entered unless absolutely essential and then only by two persons, both wearing adequate protective equipment, safety harnesses and lifelines. The lifelines should be tended by persons outside the space who should also wear self-contained breathing apparatus.

In normal circumstances the ventilators will remain sealed and no ventilation will be attempted for a cargo under fumigation. This will continue either for a stated number of days after which the spaces are to be ventilated or, less commonly, for the entire passage to the discharge port. When a space under fumigation has to be ventilated every effort should be made to prevent gases from entering accommodation or work areas. In these circumstances ventilation is best undertaken when there is a strong cross-wind, blowing exhausted air away from the ship. When ventilation takes place accommodation and work areas should be checked for gas concentrations and if they ever exceed the threshold limit value (TLV) for the fumigant the space must be evacuated.

At least 24 hours before arriving at the discharge port the master must inform the authorities that a fumigation-in-transit is being carried out and must provide relevant details. Personnel employed in opening hatches should wear respirators and the area should be checked for gas concentrations, with readings recorded in the log.

Discharge should be carried out by mechanical means. If anyone is required to enter the hold and at the completion of discharge, it should be checked for gas concentrations and respirators should be worn if required. When discharge is completed and the ship is free of fumigants and certified as such, all warning notices should be removed with these actions being recorded in the log book.

Access between ship and shore

Provision of a safe access between ship and shore is an essential requirement, a requirement which is endorsed by the laws of most if not all maritime nations. For these reasons the officers and crew of bulk carriers must ensure that a safe means of access is always provided. This is often difficult to achieve.

There is always movement between ship and quay. This occurs in the short term as a result of swell and the passing of other ships, and in the longer term as the result of tide and the loading and discharging of cargo and ballast. Because of this movement only one end of a gangway or ladder can be secured and the other must be free to move. For practical reasons it is preferable to secure the upper end of the gangway or ladder and to leave the lower end free to move but held in place by gravity. When ships' ladders or gangways are used, the fixed end must be the end which is retained aboard the ship and the ladder must slope down from the ship to the quay. This is impossible when the ship's deck is

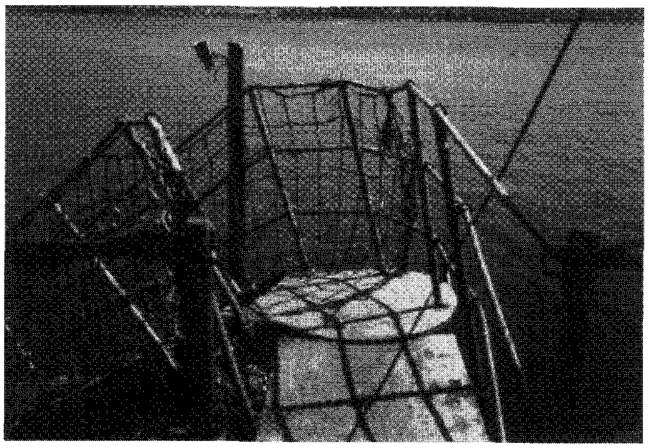


FIG 21.2 Note the manrope stanchions which are bent at the sockets. This is frequently a result of not ensuring that there is sufficient slack in the manropes before lowering the ladder. Additionally the net is not carried around the top platform to meet the ship's guardrails.

FIG 21.3 This is a good example of a well rigged accommodation ladder. The safety net is carried well beond the foot of the ladder to catch anyone who stumbles at the bottom platform. The top guardrail is rigid and soft, brightly coloured padding makes the bottom platform obvious and protects heads which might strike the bridle.

Photographs by courtesy of Captain Peter Boyle, FNI

FIG 21.4 The top and bottom outboard manropes on this ladder are too slack.

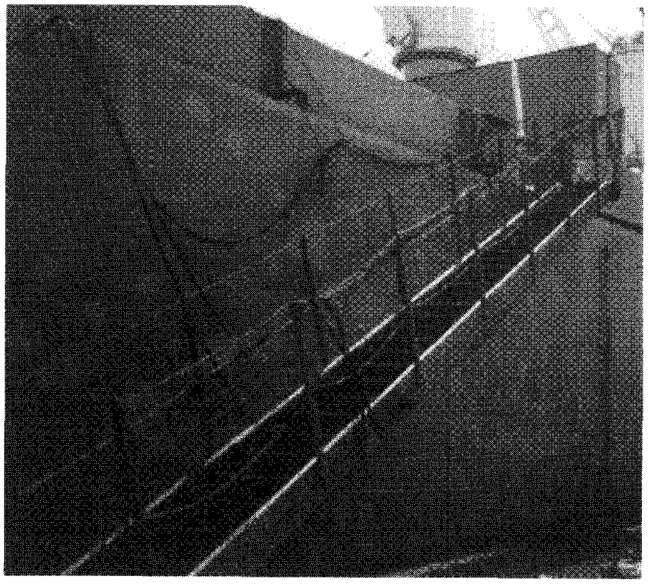
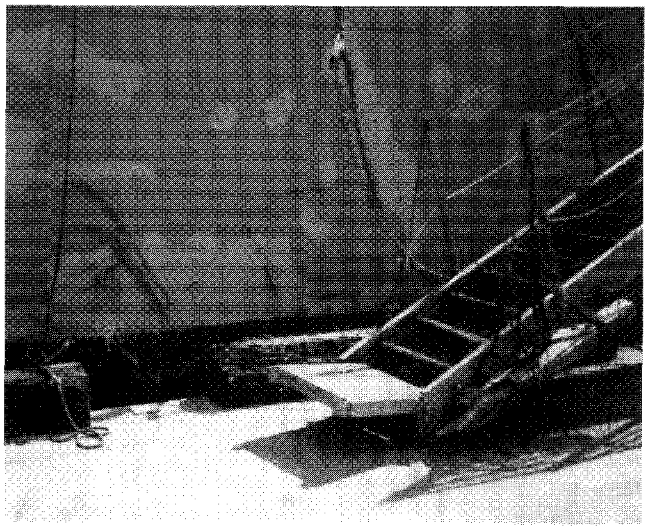


FIG 21.5 The safety net here is carried well beyond the bottom platform to catch anyone who stumbles.



lower than the quay, as is sometimes the case, and alternatives must be found.

Accommodation ladders: Ship's officers will normally choose to use the accommodation ladder in preference to the portable gangway, because the former is rigged alongside the accommodation and clear of the cargo working areas. This is safer and more convenient than using a gangway which usually must be placed somewhere on the maindeck, often adjacent to one of the working holds. In addition, the accommodation ladder is reasonably simple to rig and can usually be raised and lowered by one man using a powered winch, provided that the ladder remains suspended from its bridle, hanging against the ship's side.

Unfortunately, the accommodation ladder cannot be used when the after part of the ship projects beyond the end of the quay, as is often the case. Nor can it be used when the level of the quay is higher than that of the accommodation ladder top, as often happens at low tide and/or when the bulker is deep laden.

Even when the accommodation ladder can be used it is likely to be found that the fenders placed between the ship and the quay are so large that it is not possible to step from the foot of the accommodation ladder to the quay when the ladder is hanging against the ships' side. In that case the foot of the ladder must be swung away from the side of the ship and landed on the quay. Once that is done it requires two or three crew members to move it, as is necessary at some berths every time a new train of rail wagons are brought alongside, or every time that the loading or discharging equipment must be shifted along the quay, or every time that the ship herself must shift.

If the fenders are not wide and the ship lies close to the edge of the quay, it may be found that the bases of the loading and discharging gantries are so close to the edge of the quay that the accommodation ladder must be raised and swung inboard any time that the ship or the gantries are required to move.

Gangways: When the accommodation ladder cannot be used, a heavy ship or shore portable gangway is an alternative. The main disadvantages of such a gangway are that it must usually be rigged somewhere along the main body of the ship where cargo is being worked, and this is less safe and less convenient than an accommodation ladder. Furthermore, it is heavy and must be handled by a crane, either from the ship or from the shore, and this requires more labour and more co-ordination than does an accommodation ladder. A portable gangway is normally rigged sticking out from the ship at right angles, and in this position it is likely to prevent the movement of cranes and shiploaders along the quay and to require unshipping and rerigging at intervals.

Brows: Some bulk carriers also possess a light portable gangway or brow, made of aluminium, 5-7 metres long, and which can be rigged by about four men. This can be used when the maindeck is below the level of the quay. In these circumstances the brow can be rigged from a higher accommodation deck. The brow is normally rigged sticking out from the ship at right angles, which produces the problems already mentioned and, since the brow is short, it must be shifted to a position on a different deck when the ship rises or falls more than 3-4 metres with the tide or with loading or discharge of cargo. Some brows are designed so that they can be hooked on to the bottom platform of the accommodation ladder.

Ladders: In particularly difficult circumstances the ship may use a rigid aluminium ladder, preferably with a handrail (Fig. 21.6), set at an angle of 65°-75° to the horizontal to provide a means of access.

Means of access provided by terminal: A fifth method of access is the gangway of some sort which is provided by the shore installation at some bulk carrier berths. The best of these gangways are permanently hinged at the shore end and suspended from one of the loading or discharging gantries or from an independent mast or tower near the stern of the vessel. Such gangways normally come in the form of a walkway with a set of steps hanging from its end. Some ladders can be raised or lowered by use of a push button on an extended lead which can be brought to the foot of the gangway, a most useful feature when fitted. Even better is the gangway fitted with a sensitive detector foot which rests on the ship's deck and sends messages to controls which automatically raise or lower the ladder as the ship rises or falls with the tide and the cargo work.

If incorrectly rigged, or unsuitable for the ship in the berth, the shore gangway may lie with its fixed steps at quite the wrong angle. This is not acceptable. In most cases the permanent shore gangways, when properly rigged, are safe and convenient. Unfortunately there are many bulker terminals where no gangway of this sort is provided.

When no means of access is provided: Aboard small ships when the deck is level with the quay it is sometimes inconvenient to rig a proper means of access, but easy to step directly from the deck of the ship to the quay. Although this is convenient it can be dangerous. It is forbidden by access regulations and must never be allowed.

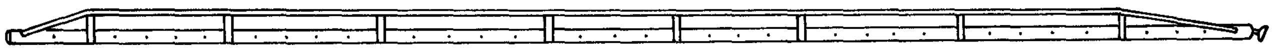
Common problems: All means of access are affected by some of the conditions met at bulk cargo berths. Because larger bulk carriers require deep water, many bulk berths are in exposed positions and the ship will surge under the effect of swell or passing shipping, creating a constant threat of damage to the means of access. Some berths are found in a filthy condition, so that there is no choice when stepping off the ship but to step into 5-10 cm of wet cargo residues (sometimes much more!) which make movement along the quay slippery and hazardous and have most unpleasant effects upon clothing.

The ship is required to move position a number of times in loading berths where the shiploader is fixed or restricted in movement, and as already noted there are a number of circumstances in which the access must be lifted out of the way to permit movement of loading or discharging equipment or rail wagons. It is often the case that three or four people are required when the means of access has to be moved, and the need to move the access can occur at frequent but irregular intervals throughout the night and the day.

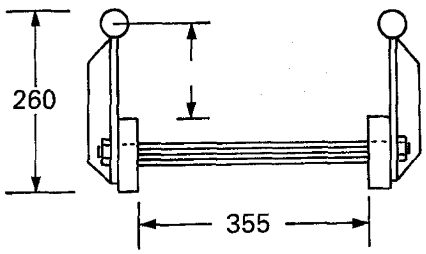
If no access is possible-for example, when the ship is berthed at dolphins and the policy of the terminal is to withdraw the shore gangway when cargo work stops-the master should protest at this on safety

BOARDING LADDERS -WITH HANDRAILS. TO DTI REQUIREMENTS.

Based on DRG No 896/83 from the Tyne Gangway Co Ltd.



SSA33 HD (handrail) 10m Ladder.
Lengths may be varied up to the maximum of 10m.
Certificate of conformity issued with each ladder.



TYPICAL SECTION

SPECIFICATION

STILES - ALUMINIUM ALLOW R.H.S.

RUNGS - EXTRUDED FLUTED HOLLOW ALUMINIUM ALLOW

HANDRAILS - MINIMUM 25MM X 10G ALLOY TUBES

NON-SLIP FEET RUBBER SUCTION TYPE

SCANTLINGS SUCH THAT THEY WITHSTAND THE LOADING SHOWN IN DTI. DOC^{T} 1729.

SSA 33HD 70KGS

FIG 21.6

grounds, as there should always be provision for people to leave or board the vessel in event of emergency. If access is refused the master must ensure that an emergency escape system is available and may require to use the ship's lifeboats in emergency.

Rules for safe access: The regulations for safe access may vary in detail from one country to another but the main requirements are common to all:

- All access equipment must be in sound repair and properly maintained in good working order.
- All lifting gear used for means of access must be properly certified.
- All access equipment must be used only for the purpose for which it is intended.
- Means of access must comply with regulations in matters such as the angle of incline, the spacing of steps and the height of fencing. Provided that standard items of equipment are correctly used these requirements will normally be satisfied.
- The access must always be properly lit. Ship's lighting should be provided even if shore lighting is adequate in case the latter fails.
- A gangway net must be secured below the means of access in such a way that it will catch anyone who falls from the access or from its approaches. This means that the net should extend beyond the end of the access to guard the space beyond (Figs. 21.2, 21.3, 21.5). When it is necessary to join two nets together the rope joining them must have the same safe working load as the nets themselves. The requirement to provide a net is often overlooked when the gangway is provided by the terminal.
- A lifebuoy with a self-activating light and a long heaving line with a quoit attached must be placed close to the means of access.
- No more than the permitted maximum number of persons or maximum loading as marked on the equipment should be allowed on the gangway or ladder at one time. In places where a large labour force is used to work cargo it may be necessary to take special precautions to ensure that this rule is observed. A notice stating the maximum number of persons allowed on the gangway should be prominently displayed.
- Arrangements for passing from the head of the gangway to the deck must be safe. When the head of the gangway rests on top of a solid bulwark, steps with handrails must be provided for stepping down to the deck.
- The upper end of a heavy gangway should be housed on a solid part of the ship's structure and not rested on light ship's side railings.
- Stanchions and manropes should be fitted around the lower platform of the accommodation ladder.
- The means of access must be properly adjusted and further adjustments must be made as required when conditions change.
- The proper access must be used and short cuts must not be allowed.

To maintain the means of access in good working order all moving parts should be carefully lubricated and regularly examined for wear. Rigging should be regularly checked and test certificates should be methodically filed. Machinery for raising and lowering the gangway or ladder should be properly maintained, and safety devices such as pawls and brakes should be regularly tested. When the steps of a gangway or ladder are wasted or worn or when the means of access is otherwise damaged, immediate arrangements must be made for its repair and it must not be used whilst in a damaged condition.

Gangway stanchions are normally provided with keys which ensure that they cannot be accidentally unshipped, but these keys may be damaged or dislodged. Accommodation ladder stanchions may be bent if the ladder is lowered while the manropes are taut (Fig. 21.2). When bent, the stanchions must be straightened and replacement keys must be welded in position. The gangway should be manned by a member of the ship's crew at all times to tend it as required by the rise, fall or surge of the ship and the passage of cranes and vehicles, and to ensure that only authorised persons are allowed on board. Regrettably, the manning levels of many ships make this difficult to achieve.

Instructions about the means of access: The officer of the watch (OOW) must ensure that the access regulations are always observed. An accident could be a personal tragedy for someone and is likely to lead to substantial claims against the ship if it can be shown that any reasonable precaution had been neglected. A checklist can assist in ensuring that all is in order.

Whichever means of access is used it will require regular and often frequent attention to ensure that it remains safe, that its adjustment remains correct and that it suffers no damage. Failure to give the gangway or accommodation ladder the attention it requires can lead to the payment of a heavy price in accidents, damaged equipment and injured or irritated users.

The watch on deck should be informed of times of high and low tide, and of anticipated movements of the ship. They must ensure that the gangway is properly secured and the manropes correctly tensioned (Fig. 21.4), and that the height of the accommodation ladder is adjusted to provide an easy step onto the lower platform from the quay.

The OOW should be aware that the gangway or accommodation ladder provides the first impression which a visitor has of the ship. Safety inspectors of various administrations will be impressed favourably by the means of access. A ship's officer with good professional standards will ensure that the gangway or ladder is well rigged, well illuminated, safe and clean before allowing it to be used for access.

Hazards from working cargo

Cargo falling during loading or discharge: A number of bulk cargoes such as quartz, iron ore and steel scrap contain sizeable lumps which can cause injury or death if they fall from a height and strike a person below. From time to time-and frequently in some cases-lumps of cargo will fall from the conveyor belt of the shiploader or from the discharging grab on to the deck of the ship or the quay alongside. Such spillage should be regularly cleared to maintain a safe access route along the deck.

For experienced seamen and stevedores it becomes second nature to avoid standing below the conveyor or the path of the grab, and this is a rule which should be firmly enforced upon any inexperienced people who have occasion to be in the vicinity of a bulk carrier when bulk cargoes are being loaded or discharged. It is good practice to forbid entry to the working side of the main deck except to those who have necessary work to do in that area. Those required to be on deck during the working of cargo should wear high visibility clothing, hard hats and industrial footwear.

Dust from cargo working: Many bulk cargoes are dusty and some extremely so. The effects of breathing dust can never be beneficial and are probably harmful in some cases at least. Where possible it is always best to avoid exposure to cargo dust, but when exposure cannot be avoided protective face masks should be worn.

Anyone who requires to be on deck when a dusty cargo is being worked and anyone sweeping cargo with a brush or with air should wear a suitable respirator. For a respirator to be effective it must be of suitable design, in good condition and worn by a person who has been trained in its use. For general shipboard use a simple respirator with a disposable filter where the wearer's lungs are used to draw air through the filter should be suitable for cargoes which are not stated to be hazardous. The European (GEN) standard for disposable filtering facepiece (FFP) respirators rates FFP1 as the lowest acceptable standard, removing about 80 per cent of the dust, whilst a facepiece rated FFP3 removes about 98 per cent[80]. All types of respirator are less effective when the wearer is bearded, or unshaven. Filters should be renewed according to manufacturers' instructions or, in the absence of instructions, when soiled.

Other safety precautions when working cargo: Smoking should not be allowed on deck when hazardous cargoes are being worked. Grain in a hazardous cargo in this respect: dust explosions have been known to occur in the vicinity of grain. Stevedores must be required to observe the same standards of safety as are required of ships' personnel. Hatch covers, whether open or closed, must always be secured so that they cannot roll in the event of a change in trim or list. A hold should never be entered when cargo is being worked except with the authority of the duty officer and the knowledge of the signaller for the cargo working equipment. Extra care must be taken when slippery cargo residues are on the deck.

Sources

67. *Recommendations on the Safe Use of Pesticides in Ships.* IMO-267E. 1980, with Supplement dated 1984.

77. *Analysis of Major Claims.* The UK P&I Club. 1992.

78. Larking, Captain R. S., MNI. The Role of a Classification Society'. *International Command Seminar.* May 1992.

79. *Code of Safe Working Practices for Merchant Seamen.* The Department of Transport. HMSO. 1991.

80. *Respiratory Protective Equipment: a Practical Guide for Users.* UK Health & Safety Executive. 1990.

81. *Boarding and Access Regulations Gangways and Ladders.* Proceedings of a Nautical Institute London Branch Seminar. 1990.

CHAPTER 22

INSTRUMENTS AND MECHANICAL EQUIPMENT

Atmospheric test equipment, hydrometers, sea water sampling equipment, whirling psychrometers, mucking winches, mobile cranes, cherrypickers, scaffolding, paint sprayers, portable sump pumps, high pressure washing machines, hold inspection systems, big area descalers, sand blasting machines, needle guns, pneumatic grease guns

THIS CHAPTER provides a description of instruments and equipment commonly used and/or particularly useful aboard bulk carriers. Important procedures are emphasised, suggestions for making the best of the equipment are offered, and problems commonly met are described. In most cases it is not practicable to provide detailed instructions for the use of the equipment and users are advised always to preserve makers' instruction manuals with care and to study them carefully before using the equipment.

Atmospheric test equipment

Atmospheric test equipment is used to test for the presence of various gases in the atmosphere. The instruments provided for this work have descriptive names such as multi-gas monitor, oxygen monitor, explosimeter, gas monitor, oxygen analyser.

Aboard ship, atmospheric test equipment is used to ensure that the atmosphere in an enclosed space such as a hold, ballast tank or void space is safe to breath before the space is entered. It is also used to detect the presence of flammable or toxic gases when these may be released by cargo or by the process of fumigation.

It is not practical to describe the full range of instruments which are available for testing the atmosphere, but these are the questions which a user must ask and which should be first considered before the start of the voyage.

- **Do we have the correct test equipment and sufficient spares for the intended voyage?** The appropriate equipment with sufficient consumable spares must be obtained at the start of the voyage.
- **What am I testing for?** Is it simply to ensure that there is sufficient oxygen to allow comfortable breathing? Or is it for methane or hydrogen, which are flammable, or for carbon monoxide, which is flammable and toxic? Different cargoes produce a variety of gases and it is necessary to know which gases may be present.
- **Is the test instrument correct for the gas to be detected?** The equipment literature must be studied to ensure beyond doubt that the instrument will detect the gas which may be present.
- **Am I familiar with the operating instructions?** The user should have a full knowledge of how to prepare and operate the instrument, and should practice in safe conditions.
- **Is the instrument properly prepared?**
  - * Clean the probe (also known as the sampling line) regularly and be absolutely sure that it is not blocked with anything.
  - * Use the appropriate test procedure to ensure that the battery is fully charged.
  - * If the instrument uses consumables such as niters or electrolyte jelly renew them as necessary.
  - * Make sure that the instrument has been set to the correct limits for the gases expected.
  - * Confirm that correct readings are obtained in fresh air and that the instrument is properly zeroed.
  - * Reset the instrument after testing.
- **How should the instrument be used?** Can the sensor be placed in an enclosed space to provide a remote reading before the user enters the space, or is it designed to give an alarm if the atmosphere becomes unsafe and to be worn by someone working in a hazardous area? Both types of instruments can be met and many can perform both functions. At least 60 seconds should be allowed for obtaining a reliable reading, a point which should be remembered particularly when an instrument is used to check the atmosphere before the user enters the space.

A quick and simple method of testing an instrument is to breath upon it. The air which a user breathes out is low in oxygen and high in carbon dioxide, so this should produce an abnormal reading from the instrument.

Hydrometers

Leadline hydrometer: Most ships are provided with metal hydrometers which measure specific gravity (also known as relative density) in vacuo. These hydrometers are intended for calculating the vessel's dock water allowance (DWA), so that she can be loaded to her marks and so that she is not overloaded.

The specific gravity of fresh water is 1.000, and that of salt water is 1.025. This number has no units: it is the ratio of the density of the measured water to the density of fresh water. The hydrometer may be graduated in readings from 1.000 to 1.040, from 1000 to 1040 or from 0.00 to 0.25, which is called an 'arbitrary scale'. These alternatives can be rather confusing and it is sometimes helpful to return to basics when calculating the fresh water allowance.

When most of the hydrometer stem is above the water, the device is floating in buoyant salt water and the DWA is small. When most of the stem is below the surface the water is fresh and the DWA is large. The value of the allowance to be used can be calculated from the formula:

$$DWA = \frac{1025 - \text{Reading}}{25} \times FWA$$

where DWA = dock water allowance, FWA = fresh water allowance, and Reading = the leadline hydrometer reading.

For example, if the loadline hydrometer reading is 1020,then

$$DWA = \frac{1025 - 1020}{25} \times FWA = \frac{5 \times FWA}{25} = \frac{FWA}{5}$$

If the hydrometer is marked with one of the alternative scales the reading will be 1.020, or .20 and must be changed to 1020 before being used in the above formula. When calculating the FWA, a correction for temperature taken from a table provided with the instrument should be applied if the temperature of the water is significantly different from that stamped on the hydrometer, which is usually 60°F or 15°C.

A metal hydrometer must be kept meticulously clean at all times. In particular, grease from fingers on the graduated portion of the stem should be avoided. The metal body must not be scratched, cracked or dented. A loadline hydrometer is intended for the calculation of FWA and is not really suitable for use in draft survey calculations, which require readings 'in air' and not 'in vacuo'. However, if the loadline hydrometer is the only one which is available a correction must be applied to the readings obtained. Values for the correction are given in Chapter 13.

Hydrometers for use in draft calculations: For an accurate density (the density in air) of dock water and ballast water, using kilograms per litre (kg/1) as the units. These can be measured directly with a draft survey hydrometer such as the glass instruments manufactured by G H Zeal Ltd, of London, which have a scale which reads from 0.990 to 1.040 kg/1. The hydrometer and water container should be kept scrupulously clean. For accurate readings the water container must be deep and wide enough to float the full length of the hydrometer. If not transparent the container must be filled to the brim. It should be at the same temperature as the water and shielded from draughts. Readings should be taken without delay to ensure that the water temperature is not allowed to change. The stem of the hydrometer and the surface of the water should be free of grease and oil. The hydrometer should be lowered vertically gently into the water until it floats and the reading should be taken where the level liquid surface meets the graduated scale.

In theory the hydrometer and the ship should be corrected for temperature when draft survey calculations are made. However, it is not practical to correct the volume of the ship for temperature and, since corrections to the volume of the ship and of the hydrometer tend to cancel one another, no corrections should be applied to either in respect of temperature.

Sea *water sampling equipment*

In some ports, water density may vary with depth, with layers of denser water lying below the less dense surface water. Density can also vary with the state of the tide and can be affected by discharges from installations. To take account of these possibilities, samples of water should be taken from at least three locations on the outboard side of the vessel and from a range of depths. A variety of water sampling devices exist[50] and includes the following.

- A length of metal pipe with threaded caps top and bottom. Holes are drilled in the top cap such that when the pot is placed in water it takes 10 seconds, say, for water to fill it. To obtain an average sample of water through the full water column the pot is lowered steadily from the surface to maximum draft in 10 seconds and will fill as it descends.
- A can closed with a cork stopper which can be jerked free when the can has been lowered to the chosen depth, thus obtaining a sample of water from that depth.

These sampling devices must be washed in fresh water after use, and kept clean and dry and free from grease and oil. Where sampling equipment for taking samples of water from below the surface are not available, it is still often possible to obtain a sample of sub-surface dock water from a drain cock in the engineroom or from a fire hydrant on deck.

Whirling psychrometers

A whirling psychrometer consists of wet and dry bulb thermometers fitted into a rotating case similar to a football rattle. The instrument is designed for use in a shaded sheltered position such as a cargo hold to find the relative humidity and dewpoint. Because the whirling psychrometer is designed to operate under different conditions to the hygrometer in a Stevenson screen, the relative humidity and dewpoint must be read from a different set of hygrometric tables.

Mucking winches

A mucking winch unit is a winch with davit used for lifting sweepings and rubbish from the holds when they are being cleaned. The winch is usually powered by compressed air from the deck air line, which is used to drive the drum for the winch hoist wire. The equipment is normally portable, which allows it to be used at each hold in turn.

The mucking winch may be worked through the main hatch opening and on Cape-sized and Panamax vessels there may be a suitable mounting permanently fixed at each hatch on a hinged davit which swings into position over the hold. Since hatches cannot be opened when the ship is working in a seaway this restricts the occasions when a mucking winch can be used. Alternatively, it may be positioned to work through a manhole cover in the hatch lids (Photo. 1.25) or through a grain trimming hatch if such is fitted, with the advantage that work can continue in rough weather. A Cape-sized vessel is likely to have a 0.5 tonne winch fitted with 12 mm wires, whilst a mucking winch on a Panamax vessel will probably be of 0.25 tonnes capacity with 8 mm wire.

Cargo sweepings and the contents of the bilges are lifted from the hold in buckets or old paint drums. The davit is free to rotate so that the load can be swung clear of the coaming and landed on deck or, with smaller davits and lighter loads, the davit may be fixed and the container is pulled over the coaming and landed on deck.

The winch wire may be subjected to rough treatment: it should be inspected frequently and renewed as soon as it is seen to be damaged or worn. The oiler/filter unit (Fig. 6.8) on the air motor should be regularly checked and the unit should be checked for physical damage and greased when being stored away after the voyage's use. Every item of equipment, including the lifting handles fitted to the paint drums, must be in sound condition since the accidental dropping of a drum of rubbish could do fatal damage to a man below. Sufficient spare wires with certificates of test should be kept aboard and spares for the air motor should include a set of air vanes and a set of spare bearings.

Mobile cranes

A mobile crane (normally stored in a garage under the forecastle head) is a feature of some Panamax and Cape-sized bulk carriers, though these have become less common since larger bulkers have been built with side opening hatch covers which reduce clear deck space in which a crane can operate. On ships which carry a mobile crane, a ramp will be provided between two of the hatches to alow the crane to cross over the deck pipework from one side of the ship to the other.

A mobile crane provides an alternative to a mucking winch for the removal of sweepings from the holds and a crane has also been used, in port, to hang the painting raft against the ship's side, providing a quickly movable platform from which the ship's overside paintwork can be touched up. A mobile crane is also useful for loading stores into the forecastle store. A mobile crane cannot be used when the ship is unsteady.

The crane wire, sheaves, jib, chassis and winch must be inspected, marked, maintained and certificated like any other item of lifting gear carried aboard ship. The handbrake system and any system for locking the wheels must be maintained in efficient working order.

Cherrypickers

Cherrypickers are self-contained units for raising a working platform attached to a series of folding arms to a height of 10-15 metres. A small portable cherrypicker suitable for a handy-sized vessel weighs about two tonnes. They are impractical for gearless bulk carriers which have no means of lowering them into the holds, but are standard equipment for some handy-sized geared bulk carriers where they are used for hold maintenance and inspection.

The cherrypicker can be lifted or wheeled into the desired position where solid base plates are jacked down to provide a stable foundation. The working platform can normally accommodate two workers, and controls for raising the platform are duplicated, with one set on the platform and a second set at the base. A cherrypicker provides a quick and efficient means of reaching otherwise inaccessible points high in the hold for cleaning, inspection, repair and painting.

Cherrypickers have been used for the painting of holds during fair weather voyages in the open ocean when the ship has been absolutely steady. Whilst in use a notice was prominendy displayed on the bridge and the officer of the watch was instructed that if he found it necessary to alter course he must first alert the cherrypicker user by walkie-talkie. On being so advised the men using the cherrypicker were instructed to bring the platform immediately to deck level. A procedure of this sort could not be used in coastal waters or in areas in which shipping was often encountered. A cherrypicker should be maintained in accordance with the manufacturers' instruction manual.

Scaffolding

Lightweight scaffolding tower units made of heavy-duty aluminium and up to 5.0 metres high when assembled have been supplied to some bulkers for use in maintenance and repair work high in the holds. Once erected they can be wheeled from one position to another and then locked in place. They are not popular as they are labour intensive and time consuming to put in position and erect, and they sway when in use unless secured with lashings.

Whilst lashing of the scaffolding with gantlines takes extra time, it is a sensible precaution and suitable lashing points can usually be found, particularly if the gantlines are led over the hatch coaming to positions on deck.

A scaffolding tower consists of up to 30 separate parts, any of which may be damaged or missing, thereby reducing the effectiveness of the complete unit. An added difficulty with scaffolding towers is that because of the hopper tanks in conventional bulkers the scaffolding cannot be erected within reach of the ship's side. Scaffolding towers have been used successfully for welding work, for scaling and for painting, but are not sufficiently stable to provide a platform for high-pressure washing systems.

Paint sprayers

Paint sprayers are a very efficient means of painting large areas, particularly irregular areas such as the outer sides of hatch coamings. However, the preparation and use of paint sprayers is skilled work, and men who do not possess the skill can waste much time and will produce finished work of disappointing quality. If even one person aboard ship such as the chief mate or bosun is thoroughly experienced and competent, he can train others and the benefits will be considerable.

The paint sprayers commonly used aboard ship are known as airless paint sprayers to reflect the fact that no air is ejected with the paint from the nozzle. However, compressed air is used to drive a piston-type air motor which operates a small positive displacement pump. The pump is used to put the paint under pressure, delivering paint at a pressure of up to 5,000 psi at the nozzle tip.

The discharge pressure must be adjusted to the pressure stated in the specification of the paint in use. Adjustment is made by adjusting the inlet air pressure. If the pressure is too high the paint will become like a fine mist. If the paint comes out in blobs the pressure is too low. Spraying should be done using the lowest pressure which gives satisfactory results. The mouth of the suction tube (fitted with a coarse filter) should always be well below the surface of the paint.

Each item of spraying equipment should be earthed (grounded) to reduce risk of static sparking. The supplier's instructions should be carefully observed. When preparing to use the paint sprayer it is essential that the correct spray tip for the type of paint and the correct type and quantity of thinners are used. Failure to get this right will probably result in failure of the equipment to spray and subsequent severe difficulties in cleaning and unclogging it. There is a temptation to use too much thinners because it appears to make the job easier. However, this results in too thin a coating of paint, so must be avoided.

Before paint spraying begins, all washers, 'O' rings and gaskets on the hand gun should be coated in vaseline to prevent excessive wear. The operator must be fully clad in waterproof-type protective clothing which can be wiped clean after use. He must wear a suitable painting respirator-a dust mask is not suitable to exclude vaporised paint. He should also wear goggles and should cover any exposed skin with vaseline or barrier cream.

Since the spray is delivered at very high pressure any direct exposure can result in paint being injected beneath the skin, where it can cause permanent injury. The spray must never be pointed directly at anyone, the safety catch on the trigger should be used any time that spraying is interrupted, and the pressure must be carefully released before the equipment is dismantled and before any attempt is made to clear a blockage.

In the area to be painted, items which must not be painted-such as rubber joints, grease nipples, instruction plates, name plates and safe working load markings-must be covered with masking tape or coated with grease. Items like valve wheels can be covered with polythene bags held in place with rubber bands.

Paint spraying must not be undertaken in windy conditions, particularly in port. Claims have been submitted for paint splashed on cars parked 100 metres away from the site of the spraying. The application of an even coat of paint-without curtains, drips or thin patches-is a highly skilled activity which must be mastered before useful painting can be done with the paint sprayer. The secret of good spraying is not to move the wrist; the whole arm should move, thus maintaining an even distance (about 350 mm) from the work.

When paint spraying is briefly interrupted the nozzle of the paint pistol should be left in a bucket of thinners to prevent it from clogging up. At the end of the day the equipment should be depressurised and the paint container should be replaced by a container of solvent (thinners) which is used to flush through the equipment. If the equipment is not to be used for some time oil should be circulated through it as a protection against corrosion. Spares for the paint sprayer are often small and valuable items which can easily be lost. They should remain in the care of a responsible person. Adequate spares should be kept aboard for the intended work programme.

Some officers consider that aboard ship the results achieved with paint sprayers are too unreliable and that unskilled crew members can achieve more satisfactory results with paint rollers. Paint sprayers are normally used in shipyards, which serves to emphasise that this is the most cost-effective option when the skill is present.

Portable sump pumps

Sump pumps (or salvage pumps) are robust and easily portable pumps which are designed to work when submerged in water or other liquids. The portable sump pumps found aboard bulk carriers are normally powered by air or water under pressure or by electricity and are of a design which permits small traces of cargo or other rubbish to be pumped along with the water.

A sump pump is very useful when a bilge or ballast suction becomes blocked or when a ballast line fails, perhaps after heavy weather, making it impossible to complete discharge of the ballast in a tank or the washings in a hold. The theoretical power of the sump pump is probably sufficient to raise water to main deck level for discharge: in practice that may be slow and difficult to achieve. In these circumstances, it will be best to pump the water to the nearest clear suction—opening the appropriate manholes to allow pumping from port tank to starboard tank, or from starboard bilge to starboard ballast tank, for example.

A fresh water wash of external accommodation paintwork has been achieved by filling the swimming pool with fresh water and then drawing it from the swimming pool with the sump pump to wash down. Sump pumps have also been used for applying whitewash to the bulkheads of a hold, drawing the whitewash from a drum standing on the tanktop, but some modern pumps are said to be too powerful for this task.

At times, when the ship is operating smoothly, the sump pump may be unused for months and may be neglected. The equipment normally needs litde maintenance, but should be cleaned by flushing through with fresh water before it is stored and moving parts should be oiled with a light oil.

High-pressure washing machines

Three varieties of high-pressure washing machine can be met aboard bulk carriers. First, there is the heavy duty Combi-gun type portable unit used for washing holds; next, there are the high-pressure washing machines permanently installed beneath the deckheads of the holds of some ships; and, finally, there are lightweight handheld units (such as Kewguns) used for a variety of washing purposes around the ship.

Heavy-duty portable washing machines: Equipment of the Combi-gun type uses conventional washdeck hoses and water from the washdeck line, boosted by compressed air at a pressure of 7 bar injected into the side of the nozzle to produce a powerful water jet which will reach the most remote parts of the hold. Some units are provided with a branch pipe which allows a chemical cleaner to be mixed in with the high pressure water jet.

The unit can be hand-held, in which case it requires at least two men at the gun, one to aim it and a second to help support the weight. Alternatively, the gun can be fastened to a stand, held in position by the weight of a single operator. An attractive feature of the gun is that it requires no maintenance and has been described as sailor-proof, although this is probably an exaggeration. The hoses which serve the unit are of the same pattern as ships' fire hoses, but fire hoses must never be used in place of Combi-gun hoses. If fire hoses are used for routine cleaning work they are certain to be damaged by the time they are required in an emergency or to pass a survey.

Heavy-duty fixed washing machines: Heavy-duty washing machines (Guncleans) are permanently installed beneath the deckheads in some mini-bulkers, with one placed in the fore end and a second in the after end of each hold. Once the gunclean has been wound down into the starting position water is piped at high pressure direct from the engineroom to the machines, which complete an automatic two-hour cycle during which waterjets are directed in succession at every part of the hold, finishing with a bottom wash. A good feature of the system is that the holds can be washed whilst the hatches are closed.

The washing system is an efficient one, although further washing may be needed after particularly dirty cargoes such as petroleum coke. At the other extreme, when the cargo has been comparatively clean, a wash with handheld hoses completed in an hour may be preferred to a full automatic wash.

Problems occur if a bilge eductor, removing the washing water, becomes blocked. If this happens the water builds up in the hold and the tanktop is not properly washed, so signs of a build up of water must be watched for. The guncleans are positioned beneath hatches similar to access hatches on the maindeck. These provide access to the gunclean for inspection and routine greasing, and the gun can be unbolted and moved to a workshop for a complete overhaul.

Lightweight Kewgun high-pressure washing machines: These lightweight hoses and nozzles produce a waterjet which is delivered at high pressure by an electric pump installed in a storeroom in the accommodation block and connected to the ship's domestic hot and cold fresh water supplies. A separate branch pipe connected to a knapsack on the operator's back or to a drum of chemical placed on deck beside him allows chemical cleaner or rust remover to be mixed in with the water.

The unit provides a thin but powerful jet or spray of water from a convenient lightweight probe. The equipment has numerous uses including the washing of exterior accommodation paintwork, the washing of oily savealls, the fresh water rinsing of holds, the loosening of mud in ballast tanks and the removal of rust stains from paintwork.

Hold inspection systems

Demands from seafarers and surveyors for simple systems to enable an inspector to reach positions high in the hold of a bulk carrier have led to the development of several systems. One of the basic requirements is for a system which is light and easily placed in the hold, even aboard gearless bulkers. It should be easy to assemble and erect and safe to use. One such system consists of a set of aluminium extending ladders with a remote securing device allowing it to be secured before climbing. A full safety harness is provided, and the system can be erected by two persons in about 12 minutes.

Big area descalers

Big area descalers are scaling machines mounted on wheels and powered by electricity, compressed air or water. They are used for scaling and wire brushing large areas of deck plating. This is achieved by fitting the scaling or the wire brushing head, switching on the machine whilst the machine is tilted and the head is not in contact with the deck, bringing the rotating head in contact with the deck and wheeling the machine slowly back and forwards across the deck. Chipping leaves and brush heads must be renewed when worn and the machine must be lubricated as recommended by the manufacturers.

Sand *blasting machines*

Sand blasting machines are powered by compressed air and used to sandblast steelwork on the maindeck or in other positions to which the machine can be lifted. A cylinder mounted on wheels is filled with sand or other abrasive and is pressurised to a maximum working pressure of 125 psi. A hose and nozzle attached to the cylinder is used to direct the sand blast at the area to be cleaned. To avoid injury the nozzle must be held in the blasting position before the generator (i.e., the cylinder) is pressurised. From time to time the machine must be refilled with sand. The sand which has been discharged should be swept up and used again until such time as the rust content in the sand becomes high.

Needle guns

Pneumatic needle guns have a barrel from which a number of needles project. When the air supply is opened up the needles reciprocate rapidly in a way which is very effective for descaling uneven surfaces. The tool will get into grooves, corners and gaps very efficiently and is well suited for use in spaces which are too confined for other tools.

The equipment operates at 70-100 psi, and should be used with an oiler/filter unit. It should be stored in dry surroundings. After use and before storage, spindle oil should be applied to the air inlet and the tool should be operated for a few moments to distribute the oil throughout the tool.

Pneumatic grease guns

Aboard a bulk carrier one of the most useful pieces of equipment is a pneumatic grease gun. Essentially this consists of a drum of grease on a wheeled trolley. Air pressure from the deck air line is used to put the grease under pressure and to deliver it through the flexible hose to the grease gun. While one man wheels the trolley about the deck the second is able to move briskly from one grease nipple to the next, pumping grease into the places where it is required.

Sources

60. *Code of Uniform Standards & Procedures for the Performance of Draught Surveys of Coal Cargoes.* United Nations Economic & Social Council. Economic Commission for Europe Committee on Energy, Working Party on Coal. 1992.

149. 'Framewalk-a system of ladders'. *Seaways.* January 1993.

198. Instrument Operating Literature from MSA, Explosimeter, Neotex, Servomex, Drager.

199. Equipment Operating Literature from Altas Copco, Clasco, Graco, Wilden Pumps, Str0mme, Flexotube-Trident, Nitto Kohki Co. Ltd., Paul & Griffin, Fujiki Trading Co Ltd, Kobe Cleaner MFC Co, Yati.

202. Instruction leaflets supplied with hydrometers from G.H. Zeal, Ltd., London, England.

CHAPTER 23

MAINTENANCE

Planned maintenance systems, the planning of maintenance, management of spare parts, greasing and oiling, painting, maintenance of derricks, cranes and grabs, ship's fixtures and fittings

MOST bulk carriers are exposed to demanding working conditions in the unforgiving marine environment. If a bulker is to remain seaworthy, safe and efficient throughout a working life of 15 years or upwards she must be properly maintained throughout that period. There are some signs, in 1993, that the importance of this is becoming more widely accepted. Underwriters and P&I Clubs are even withdrawing cover from ships which have not been maintained at the minimum standards required to keep them seaworthy-a welcome step indeed.

The principles and procedures for good maintenance are stated in this chapter. Everyone aboard ship has his or her part to play in keeping a ship well maintained, but good maintenance also requires owners and managers who are prepared to pay costs reasonably incurred and to provide the support which ships' staff require. Good planning should be encouraged or imposed and the resources in terms of money and manpower must be provided when necessary. Good maintenance also requires competent and reliable suppliers of services, spares and stores, and these are available in many parts of the world.

Good maintenance is not an optional extra. It is an essential part of keeping a ship in a seaworthy condition and should be practised aboard ship from the day she is delivered by the shipbuilders.

Planned maintenance systems

Value: A planned maintenance system, if well designed, provides a useful scheme for deck maintenance aboard a bulk carrier. The system, which may be computerised or may rely upon record cards or looseleaf binders, lists all the maintenance work that the ship requires and the frequency at which it should be done. A single system may include all areas of activity or separate systems may be provided for different areas and categories of work. For example, there may be separate planned maintenance systems for deck, bridge, safety equipment and engineroom. From an inspection of the planned maintenance records it should be easy to see when an item of maintenance was last done, what was done, when it is due for doing again and, possibly, what materials will be required and how many manhours the work will typically take.

Planned maintenance systems are intended to move deck maintenance away from a regime in which tasks are undertaken in response to a succession of crises, or are concentrated on superficial appearances, to a system in which every item of equipment, structure and fittings receives the maintenance it needs to ensure its continued efficient operation. When sufficient resources in terms of equipment, supplies and manpower are made available and when the system is well designed and managed there can be no doubt that a planned maintenance system is a very good way to ensure that a ship is well maintained.

Even a planned maintenance system which is well designed and well supported cannot always match the difficulties created by foul weather and a hectic succession of short voyages with dirty cargoes, but it will help the ship's officers to make the most of such opportunities as they have.

Not to be accepted uncritically: Planned maintenance systems provide a very useful reminder to the chief mate of work that requires to be done, but the system should not be followed blindly. It is only as good as the people who designed it and important items can be overlooked-for example, one system in use aboard four sister ships did not list the painting of the bridge front. The planned maintenance system should be examined critically and important work which does not appear in it should be done and should be inserted into the system by whatever method is appropriate.

Restarting a planned maintenance system: Some masters and chief mates will undoubtedly have the depressing experience of taking over a ship with planned maintenance records which have not been kept up to date, with a gap which extends for months or years. In these circumstances it is probably best to resume maintenance according to the plan at the correct intervals. In addition, the items which are listed for attention only at long intervals should be examined at an early date. For example, if the windlass brakes are listed to be opened up for inspection only once a year it would be a mistake to leave them for a further year before inspecting them.

Maintaining planned maintenance records: Planned maintenance records should be updated methodically and frequently to avoid the inconvenience which occurs if the officer responsible has to leave the ship unexpectedly and fails to bring the entries up to date. Daily updating of the records is to be recommended.

Records when maintenance cannot be done when due: Operational pressures are sometimes so great that there just is not time to complete the maintenance work on schedule. In these circumstances there may be a temptation to make an entry showing that maintenance work has been done when in truth it has not. This should never be done: it is likely to be more damaging to the ship than the failure to do the maintenance on schedule. Reliable maintenance records are essential to a well-maintained ship, and officers should never be penalised for keeping honest records even if they show that scheduled work has not been done.

When it is clear to a chief mate that work cannot be done on schedule he should inspect the area scheduled for maintenance and make an entry in the records such as *No opportunity for maintenance, but item inspected on 27.4.93 and considered fit for service until next due maintenance date.* That makes the situation absolutely clear to a reader and will give added urgency to the attempt to carry out the maintenance on the next due date.

Operational work: Much of the work aboard a bulk carrier is operational, particularly when a vessel is engaged on short voyages. Hold preparation, berthing, unberthing and shifting ship must be done when required and cannot be completed according to a plan.

When there is no planned maintenance system: Even when the ship is not provided with a planned maintenance system the maintenance should be planned. A vital element in this planning is a full record of work done, and if the ship has no planned maintenance system the chief mate should maintain a work record book with details of the deck maintenance work completed by the crew. This should give the date, should provide a full, exact list of the items maintained and should state clearly what treatment they received, using terms such as *stripped down, renewed, end-for-ended, scaled, wire brushed, primed, undercoated, glossed,* and *greased.*

The chief mates of many bulk carriers complete *Monthly Deck Work Reports* for owners which provide an indication of work done, but may not be sufficiently detailed for the purposes of on-board planning.

Planning of maintenance

Work lists: The chief mate should receive from the man he relieves a list of work planned for the coming period. As soon as he has settled aboard ship this list of work should be updated, taking account of the requirements of the planned maintenance system if there is one and of any additional work which the chief mate considers to be urgent. The captain and chief engineer and the owner's superintendent may also have useful suggestions as to work which needs to be done.

Priorities: It is useful to sort this list into work to be done in different circumstances, and to list it in order of priority with the most important jobs first. The most difficult maintenance work to complete aboard ship includes the renewal of overside paintwork, which requires time in port, fair weather and a ship's side free of condensation, so this must be given high priority. The renewal of hold paintwork requires holds which are empty and clean and a steady ship for a period of days. Work within the double-bottom ballast tanks (DBs) is difficult to arrange aboard small bulkers because these tanks are full when the ship is in ballast and their manholes are overstowed with cargo when she is loaded. Aboard large bulkers the DBs can be entered at any time through the stool spaces, so maintenance work can be undertaken during loaded passages, provided the stool spaces can be entered from the duct keel.

Greasing is essential work which, fortunately, can be undertaken on deck whenever it is safe to go on deck and the same is true of the stripping down and overhaul of cargo handling gear aboard geared bulkers. Provided that the ship is not rolling very heavily and that seas are not being shipped, this work can proceed, as can the overhaul of deck machinery and hatch cover fittings and the renewal of pipework on deck.

Scaling and painting on deck, however, require dry conditions which are only found on a loaded bulker in a flat calm or, better still, in a light following wind. In any sort of adverse weather, a loaded bulk carrier will repeatedly ship salt spray over the greater part of the main deck making painting impossible. During ballast passages the increased freeboard provides drier conditions, but the air is still likely to be laden with salt spray during periods of adverse weather.

When the weather is very rough work within and around the accommodation and the machinery spaces is most suitable. This can include the overhaul of the contents of enclosed lifeboats, the cleaning of ventilation louvres in cabins, the tidying of storerooms and the overhaul and refurbishment of spare fittings for hatch covers, and for cargo gear (if carried). In high latitudes in winter, when the weather is cold and dark, work within ballast and fresh water tanks can usefully be undertaken and this applies also during extended periods of heavy rain.

The annual work plan for a geared mini-bulker employed in the European middle trades is at Appendix 23.1.

Confirming requirements: One of the most important reasons for planning the work programme in advance is that the programme can only be put into effect if the necessary tools, spares and consumables are aboard. Not a few major opportunities for maintenance have been lost when it has been discovered once the ship was at sea that the paint spray was damaged or incomplete, or the supply of grit for the grit blasting machine was exhausted after the first day's work. If there is not sufficient paint of the correct type and colour for the area to be repainted the consequence is the same.

A programme of overhauling the quick-acting cleats on the hatch covers cannot be satisfactorily completed if the supply of spare neoprene washers has been used up. If the windlass brakes are opened up for inspection and the linings are found to need renewal the work will have to be repeated if no spare linings are carried. The brakes will have to be re-opened at a later date.

Making requirements realistic: The estimates of the quantities of stores and spares required must be realistic. With paintwork that is not difficult provided that the area to be painted is measured accurately. Manufacturers' literature will show the number of square metres which a litre of paint will cover and stocks must be sufficient to complete the job, with 10 per cent extra for contingencies or for touching up at a later date if not required for the initial painting. With consumable hatch spares, such as the neoprene washers for quick-acting cleats, which have a life of about two years, it is reasonable to carry sufficient for the complete renewal of one hatch or 25 per cent of the ship's total, whichever is greater, unless it is obvious that a great number throughout the ship require renewal in which case more spares should be carried.

Planning the task: If the chief mate is to be sure that the ship has all the necessary tools for the intended work he must have a clear idea of how the work is to be done, and this will sometimes be a problem for the inexperienced chief mate who has need of this advice. It is not possible in this book to provide descriptions of how to organise even the main maintenance tasks, but it is possible to list the questions which the chief mate should ask himself before putting the work into hand and these are given in Appendix 23.2. An experienced chief mate will ask himself these questions, but the process will be a rapid mental one as he will have a clear idea of how the work is to be done and will know many of the answers before he starts.

Confirming that the equipment is ready: When the required tools and equipment have been listed they must be checked to confirm that they are all ready to use. It can never be assumed that equipment is in good working order unless the people who last used it are reliable and are still aboard the vessel. Without this assurance that all is in order, necessary equipment such as paint sprays, scaffolding, chain blocks and grit blasting machines should be tested to make sure that they are complete and working. This will allow time to purchase spares or to plan other work if spares cannot be obtained in time.

Management of spare parts

Maintaining stocks of spare parts: When a ship is provided with a number of identical items of equipment such as cargo winches, roller fairleads, mooring winches, hatch motors, hatch hydrocleats, ventilators or airpipes a minimum of at least one set of spare consumable parts such as bearings, gaskets or complete units should be carried. In many cases, when regular use of spares or renewal of units can be foreseen, a larger number of spares should be carried.

A rule to be remembered in this connection is obvious, but is still often forgotten; as soon as spares are used, replacements should be ordered! A ship which only orders a replacement when the item in use is damaged or worn out will never operate at full efficiency and will always limp from crisis to crisis. Much more time is lost when equipment has to be cannabalised or moved from one place to another than when a replacement can simply be bolted or shackled into position.

The negligent sequence of events which is all too common, but which should never be allowed to happen, is as follows. A new ship has no need for spares for several years after being brought into service. Gradually, fittings begin to wear out or break and are replaced by the ship's original stock of spares until the spares are all used. As fittings continue to fail equipment is cannibalised, or is moved from one position to another where the need is more urgent. By this time the ship no longer has a full set of working items, there are no spares, and no spares are on order. Where necessary, ships' officers must be prepared to insist upon maintaining a minimum stock of spare parts to ensure the ship's efficient operation.

When a ship is provided with a computerised spare parts system, and when that system is understood and kept up to date, the control and reordering of spares is usually easier. The best of such systems are quick to access and, in addition to providing a full specification of the part and the quantity in stock, will recommend the appropriate level of spares taking account of the number used in the past. They will even print an appropriate order for the supplier or chandler.

Ordering spare parts: A good rule to follow when ordering spare parts is to assume the least amount of knowledge and experience on the part of the person supplying the items ordered. Orders should always include: the part number and/or name; the machine number and/or name; manufacturers' name and address; number of items wanted; colour, grade, type of fitting; and sizes and other details of items wanted, if applicable.

Wherever possible spare parts should be ordered from a catalogue or spare parts list, and part numbers should be used in preference to names used aboard ship, which may be incorrect. If the ship does not have a spare parts list that should be ordered from the manufacturer. The catalogue of the International Ship Suppliers' Association (ISSA) provides a useful standard vocabulary and a set of codes which are known and used worldwide.

Caring for spare parts: Spare parts carried aboard ship are useless if they cannot be found or identified when required or if they are kept in damp or dirty conditions and allowed to deteriorate. Spares should be labelled, kept in tidy storerooms and protected from damp.

Records of the spares aboard ship should be maintained. Such records can be in the form of a spares and stores duplicate book, completed at regular intervals, with one copy for owners and one to remain aboard the ship. Alternatively, a card index system, or computerised records can be maintained. A useless broken part of equipment or machinery should never be kept unless it is needed as a pattern for the replacement part, to be reconditioned, or needed as evidence for a claim. Parts which are being kept should be clearly labelled. All other discarded parts should be removed from the ship, to prevent overcrowding in storerooms and to avoid later uncertainty. A 'used but good' part must never, ever, be put into the store with new stock in the packaging from which the new part was removed.

Reconditioning spare parts: Many items of equipment such as cargo blocks, hatch hydrocleats and guncleans are suitable for reconditioning. Provided that spares are carried, a defective item of equipment can be replaced by a spare. At a convenient later date the defective equipment can be overhauled and reconditioned in the ship's workshops, by renewing bushes, seals or other damaged parts, thus preserving the value of the item and making it again available as a spare. Alternatively, the item can be landed for reconditioning by the manufacturer and later return to the ship.

Greasing and oiling

Lubrication of moving parts of equipment is essential to prevent gear from seizing up and becoming damaged. As a general rule it must be assumed that whenever there is movement between two or more pieces of metal the area where they make contact must be greased or oiled. Provision for such lubrication is always provided in machinery and fittings. Normally the grease nipples and the oil sumps are readily seen, but occasionally they are very difficult to find and are overlooked. There have been mooring winches on which the nipple for greasing the bearing could only be seen and used after the wire had been removed from the drum, and extended spindles have been installed 'wrong way round' with the grease nipples facing the bulkhead. Grease nipples usually project from the machinery upon which they are fitted and are sometimes sheared off, leaving little to show that they were once there.

All the foregoing examples-and many, many others-have led to the failure to grease items as required and to the equipment seizing up (at heavy cost) at a later date. Ratings have no difficulty in recognising grease nipples and applying grease to them, but it is unwise to assume that they will recognise the places which need greasing but which do not appear to have a greasing point. It is the job of a responsible officer to look critically at every fitting on the deck-the hatches, in the storerooms, around the lifeboats and the accommodation-and to make sure that the rule is being followed: if it moves, grease it!

On a bulk carrier, where much greasing must be done on deck, the work is normally done with a pneumatic grease gun (see Chapter 22). Items which are out of reach of the pneumatic grease gun can be greased with a hand-held gun.

For proper lubrication a number of rules must be observed.

- The correct grease or oil must be used for each item. Whilst a general-purpose grease is suitable for most deck fittings and equipment, named high-grade oils and greases are often recommended for particular pieces of machinery. As always the makers' manuals or owners' instructions must be consulted for details. To ensure that the right lubricant is used for the correct equipment a competent crew can be provided with separate grease guns, suitably loaded, for separate jobs. If the crew competence is poor it will probably prove cheaper in total cost to use the better quality lubricant for all the greasing: it may be more expensive in the short term, but will pay for itself in reduced wear.
- Ships operating in sub-zero temperatures for long periods should use greases and oils which are efficient in very low temperatures.
- Grease should be pumped into a grease nipple until grease starts to squeeze out from between the moving parts of the equipment. If grease cannot be forced into the nipple and out between the moving parts the item must be marked for dismantling and cleaning of the grease channel as soon as possible.
- Damaged or missing grease nipples must be replaced.
- Sumps for deck machinery must be kept topped up to the proper level with clean lubricating oil. The correct oil to use must be found from the makers' manuals, and the ship's engineers can usually provide further advice if needed. If the lubricating oil is found to be dirty, contaminated with sea water, or leaking away quickly the cause must be found and the oil renewed.
- If it moves it must be lubricated!

Painting

Correct paint system: Painting is the principal process by which the ship's structure and fittings are protected from corrosion in an environment which is salt laden and hostile. Paintwork also has a decorative function and can give a ship a pleasing appearance. A ship normally leaves the builder's yard fully painted. Thereafter painting is required to repair, renew or reinforce the original paint coating. Repair of paintwork is done by touching up the damaged areas. Renewing paintwork involves removing all paintwork down to the bare metal and applying a full set of replacement coats, and the original paintwork is reinforced by applying additional coats on top of the previous paintwork, a process which should be started as soon as possible after the ship leaves the builder's yard.

A number of different marine paint systems using paint with different chemical structures are nowadays available. These include conventional and bituminous, chlorinated rubber, vinyl, epoxy and antifouling paints and a variety of special coatings. It frequently happens that different systems will be used for different parts of the same ship, with one system used for the topside paint, another for the holds and yet another for the insides of ballast tanks, or with one system for the decks and another for the hatch covers, for example. In many cases paints from different systems cannot be used together, and paint from one system will not adhere to paint from another system. Even when the new paint will stick to the old it is most unwise to change paint type, since there was probably a good reason for choosing the paint which was first used, and problems may arise later.

Before the chief mate starts on a programme of repainting and when he is planning the work, he must be sure which is the correct paint system to use. This is likely to be particularly difficult when the ship has changed paint supplier, or owner, or both. It is quite acceptable to use alkyd (conventional) paint made by manufacturer 'B' to cover alkyd paintwork supplied by manufacturer 'A', but chorinated rubber paint, say, from any supplier should not be used over alkyd paint. When paint is ordered the fullest details should be provided using codes wherever possible to avoid confusion.

Before the work starts the chief mate must be certain which paint system is being used, which are the correct thinners and brush cleaners to use, and whether the paint is intended for application by spray or by brush. He must also be sure that the primer he uses is correct for the surface being covered and that it belongs to the same paint system as the topcoat with which it is to be used.

The necessary information is simple enough and can readily be found in the product literature, but when the ship has no literature from the paint manufacturer, or when the bosun does not speak the language in which the paint labels are written, there are plenty of opportunities for mistakes to be made and care must be taken to avoid them. When necessary paints, primers and thinners for one painting system should be stowed completely separately from those of another system and someone who can read the paint labels should be employed to mark them with a symbol or letter code to identify each paint type. The paint manufacturers do not want to be associated with painting disasters and will normally be ready to offer information and advice.

Surface preparation: A paint manufacturer" advises that by far the best preparation for bare steel is blast cleaning if rusting at a later date is to be avoided. Aboard a bulker equipped with a sand or grit blaster there will be occasions when deck areas, hatch coaming and covers, hold steelwork and other large areas can be blast cleaned, but often it is not practical to use the sand blaster, so surface preparation done by the ship's crew will be carried out with scaling machines, needle guns and powered wire brushes, tools which prepare the surface in a less satisfactory manner. Where possible a surface which has been scaled should be smoothed using a powered grit discing machine before it is painted.

The surface to be painted should always be free of salt. To achieve this the surface must be washed with fresh water and painting must not be done when there is salt in the air (as there is when conditions are windy, or when the ship is proceeding at service speed, causing spray to rise over the fore part of the vessel). If these rules are ignored and paint is applied over salt the paint will peel off after a few days or weeks.

The surface must be free of oil, grease and other contaminating substances and, for most paints, it must be absolutely dry. This means that paint cannot be applied to a surface which has not dried properly after washing, nor can a surface which is misted with condensation be painted. The latter condition occurs when a ship carrying cold ballast water arrives in a tropical port: condensation forms on the steel deck and topside plating when the warm air meets the cold plating. Condensation can be prevented by changing the ballast water in the topside tanks when tropical waters are reached. Washing with fresh water can be done with a lightweight high pressure gun such as the Kewgun (Chapter 22).

Touching-up: When a paint coating has suffered mechanical damage in places as a result of contact with a grab, a fender, a tug or some other object such as cargo spilt from a grab, or as the result of local rusting, and when the undamaged paintwork remains in good condition the damaged area can be touched up. For effective touching up the area must first be properly prepared by descaling and by smoothing the paintwork at the boundaries of the damage with a disc sanding machine. Next the damage must be wire brushed, washed with fresh water and dried, after which the bare steel can be painted with a rust remover and then primed and coated with gloss.

When the damaged area is on the ship's side and the stay in port is short the descaling may be limited to scraping away loose paint and rust with a scraper before washing, treating with rust remover, priming and painting.

Reinforcing paintwork: Paintwork is reinforced by applying an additional full coat of paint over the previous paint. This is the appropriate maintenance when the paint is in good condition, though becoming dull and worn, or when it has been touched up, and looks patchy. Before applying an additional topcoat it is usual to wash the paintwork with a synthetic detergent and then to wash it with fresh water, to remove all traces of salt and contaminants.

Renewing paintwork: When an area of steelwork is badly rusted, or when the paintwork is irregular and badly damaged the only worthwhile treatment is to take it back to the bare metal by blasting or scaling the entire area to remove all paint and rust. When this has been done, the area must be swept free of loose dirt, washed with fresh water, dried, coated with rust remover and then primed and painted.

Maintenance of ships' cargo-handling gear

The importance of ship's cargo-handling gear-the derricks, cranes, grabs and, in the case of specialist ships, conveyor belts or gantries-is clear. If the equipment does not work efficiently when required the ship will be penalised for time off hire. If the equipment has not been maintained in compliance with the regulations the infringement of regulations may be found by inspectors and, again, the ship may be subjected to expensive delays.

Sometimes a geared bulk carrier may trade for months or years without being required to use the ship's gear for loading or discharging. When this happens there is a danger that other matters may seem more urgent and the cargo gear may be neglected. This should never be allowed to happen, because the expense and time required to upgrade gear will always be more than that required to maintain it in good condition, and because there is always the possibility that circumstances will change unexpectedly and the gear will be required for immediate use.

Derrick maintenance

There are two basic requirements when maintaining cargo gear: to keep the equipment in good, safe working order; and to keep the supporting documentation in good order. The derricks fitted to handy-sized and mini-bulkers are composed of a large number of components and are demanding in maintenance time. The maintenance of the derricks and associated gear aboard a ship which has been well maintained can be summarised as follows:

- **Daily, when derricks are being used to work cargo.**
  Inspect runner wires for wear or damage. Check the rig for damage for for fastenings becoming slack.
- **Before arrival in port.**
  Inspect derricks and associated gear to ensure that they comply in every respect with the requirements of the flag State and of the port to be visited.
- **Periodical** (visual) **survey.**
  The frequency of this survey is decided by the ship's national authority. Most authorities require the survey to be done annually but some, such as the Australians, require surveys at three monthly intervals. The survey must be done by a competent person, often the chief officer, though some authorities require the survey to be carried out by an independent surveyor.

  When the ship's cargo gear is in frequent use all the checks required by die survey should be done by ship's staff more often than once a year, even when the regulations only require an annual survey.

  The main requirements of the survey are summarised hereunder, but anyone intending to undertake a survey should study the full detailed requirements listed in the appropriate government and classification society publications.

  * *The rigging arrangements must conform with the rigging plan.*

  * *Before examination:*

  All assembled items such as goosenecks and blocks should be dismantled so that their component parts can be readily inspected.

  Shackles, links, rings, hooks, triangle plates, chains, etc., must be sufficiently free from paint, grease, scale, etc., to enable a proper inspection to be made.

Serving must be removed from splices in wire ropes.

* *The examination is intended to find any of the following:*

Deformation, wear, scoring, corrosion, scars, dents, or other defects to structure and fittings.

Free movement and efficiency of lubrication of moving parts.

To confirm that every item of gear is clearly marked with a safe working load (SWL) and with an unique reference mark (set of numbers and/or letters) which can be matched with a certificate of test.

* *Items to be examined:*

Masts, derrick posts, guy posts, and the structure in way of them.

Derrick boom and mast fittings including lugs, goosenecks, heel pins and heel block anchorages. (If metal appears to be wasted or worn the thickness should be checked, using calipers, against the original specification. Lugs are particularly prone to wear.)

Fittings on deck such as stoppers for wire ropes, eyeplates, cleats.

The derrick boom, particularly at the point where it rests in its crutch, or housing. (Make sure boom is not bent. Hammer test if necessary. Move boom through all working positions if necessary.)

Blocks.

Shackles, links, rings, hooks, triangle plates, chains, etc.

Wire ropes should be inspected over their entire length, with particular attention to end fittings, ferrules (mechanical splices, compressed crimp fittings, Talurit splices) and splices. The condition and security of thimbles and the condition of the wire surrounding them should also be carefully examined. Wire ropes must be renewed if the number of broken, worn or corroded wires in any length of ten diameters exceeds 5 per cent. For example, if the wire rope has a diameter of 30 mm and is of 6 x 24 construction the total number of wires in the rope is 148, of which 5 per cent is 8. If more than 8 broken strands are found in a length of (30 x 10) mm-i.e., 300 mm-the rope must be condemned.

Fibre ropes should be examined over their entire length for external chafe and cutting, for internal wear between the strands, for mildew, rot, chemical attack or other contamination.

* *Inspection of test certificates:*

To confirm that the test certificates for shackles, links, rings, hooks, triangle plates and chains show the material used to make the item-mild steel, high tensile steel or alloy steel.

To ensure that there is a valid test certificate for every single item of gear shown on the rigging plan. (To be valid all the details entered on the certificate must be correct for the item of equipment to which it applies.)

* *Any item of cargo gear which is repaired must be retested and certified.*

- **Quadrennial thorough survey.**

The quadrennial survey must be done by an approved surveyor, who usually represents a classification society. It is more thorough than the periodical survey. Besides including all the work for a periodical survey, the quadrennial survey requires the retesting of the derricks and thorough examination of all parts of the derrick and its associated gear. This may involve the removal ashore of the loose gear to a proper workshop where it can be examined, retested and remarked. In some cases the unrigging and rerigging is done by riggers who are familiar with the system adopted by the repair yard and can ensure that all gear is unrigged and rerigged in positions corresponding to the plans which the yard provides for the ship.

Conduct of the periodical survey: It should not be thought for a moment that a periodical visual survey of a single derrick can be completed in a few hours. Even when all the derrick gear is well maintained and the crew are experienced in the work of dismantling it, the task will be time consuming. A team of three or four experienced crew members will probably require at least two days to lift the heel of a 5 tonne derrick clear of the gooseneck, to release all the shackles, to remove the sheaves of the topping lift, runner and guy blocks and inspect the block swivels, to inspect every item and verify the markings, to make renewals as necessary, to grease and oil and to reassemble the rig.

When the parts of the rig are heavier, when the rig is more complex, when it has been neglected or when the crew is inexperienced the work will take correspondingly longer.

Need to keep the documents hi good order: An inspector or surveyor of cargo gear when visiting the ship will expect to be shown on demand a certificate for every separate item of gear. If the ship is to comply with such a request the cargo gear documents must be kept methodically and it is essential that the chief mate understands the records and their importance and ensures that they are kept up-to-date.

A variety of systems are used by different shipowners and ship operators for the efficient filing of the cargo gear certificates. The basic requirements of any system are the following:

- If a shackle stamped 'F33 SWL 5T' is found in the cargo gear it must be possible to produce a test certificate for that shackle.
- If asked for the certificate for the derrick-head topping lift block on the No.3 forward starboard derrick it must be possible to produce a test certificate for that block, and the reference number on the certificate must be the same as the reference number on the block.
- A certificate must be held for each wire rope used in the rig.

Methods of keeping the documents in good order: There are a variety of practical difficulties in complying with the foregoing requirements, and the following guidelines may be useful.

- When a number of items of cargo gear are supplied to the ship, each item should be supplied with a separate certificate and this should be stated when ordering the items. For example, if ten 5-tonne shackles are supplied, a single certificate for *10 shackles, Nos. F25-F34* is not acceptable. A separate certificate should be provided for each shackle. Two years later, when three of the shackles are lost, two are unused and remain in store, and five are in use on three different derricks, each certificate can then be placed with the appropriate set of documents.
- Wire ropes may be supplied in coils and the coils may be cut to provide rigging in several different places. For example, a single coil of wire rope might be used to

make six guy pennants for different derricks. As the coil is used, a record of the usage must be kept with the certificate. The note attached to the certificate might read, *CertificateNo. C13774. 220 metres, 22 mm diameter. 6 x 10 metres used far guy pennants at IP, IS, 2P, 2S, 3P and 3S. 160 metres remains in forecastle store. Date: 26.10.92.*

- Records of this sort must be kept up-to-date and accurate. The regulations of most maritime nations require that the ship maintains a full set of certificates for all lifting appliances, including cargo gear. A surveyor will expect to find that the chief mate's records are reliable and up-to-date.
- The records must be kept with the same care and accuracy even if the ship's only derricks are stores derricks.
- A single certificate may refer to items of gear which are in use in a number of different places, like the coil of wire quoted in the example above. In this case a photocopy of the certificate can be placed in records in each place where the certificate should appear. The photocopies should be endorsed with a note stating where the original certificate is filed.
- It is often helpful to write notes, in pencil, on the certificates of test for spare items of cargo gear. Such notes could read *To be usedfor the renewal of3P & 3S topping lifts,* or *Placed in poop store-to be moved to forecastle store.* Such notes can be erased or amended when circumstances change.

Marking of items of cargo gear: Every item of cargo gear is required to be marked with identifying reference numbers and/or letters. Steel items usually have the numbers punched on them and these numbers can become very faint as a result of paint, rust or abrasion. The numbers should be kept clean by wire brushing, and can be painted with a patch of paint of a distinctive colour to help to find them quickly. If the markings become very faint they can be repunched to make them more clear, but it is essential that the markings are not altered in any way.

When wire ropes are manufactured with ferrules (mechanical splices) at their ends or on their splices die reference numbers of their certificates will be stamped on the ferrules, so that the wire rope can be matched with the certificate. When the wire rope has no ferrules it is normally delivered with a metal label with the test certificate reference number fastened to it. When such a wire rope has been put into the derrick rig it can no longer be labelled, so it is essential that the ship's records show which certificate refers to each of the wire ropes in use. The records must be kept up-to-date as the renewal of wire ropes is carried out, because attempts to update the records later nearly always run into trouble. Records prepared after the event are likely to show the same wire rope fitted in two different positions, or a wire rope which is 70 metres long matched with a certificate for a 50 metre wire rope, or other impossible data which discredit the records.

Each derrick boom must be prominently marked with the safe working load of the derrick. When more than one system of rigging the derrick is possible-for example, when the gear can be used as a swinging derrick or in union purchase-the safe working load in each rig must be shown. This is often marked on the boom with lines of weld and painted.

Neglected cargo gear system: Updating a neglected system for marking every item of cargo gear and providing its certificate is a very big job which is best done by a repair yard using professional riggers. Some owners make it their pracdce to have the ship prepared even for the annual examination by riggers. If the crew are inexperienced or small in numbers, or if the ship's schedule is a busy one and the cargo gear is often used, this is probably the only practical method of ensuring that the cargo gear and associated records are properly maintained, and it seems likely that this procedure will be adopted with increasing frequency.

Crane design:, maintenance and operation

Crane design: Shipboard cranes are usually of electro-hydraulic design. A crane is normally required to perform three functions-namely, to hoist, to luff, and to slew. Hoisting is the raising of the crane wire whilst the crane jib remains in a constant position. Luffing is the raising or lowering of die crane jib, and slewing is the swinging round (or rotating) of the crane. Cranes on a few ships are also able to travel along the deck on rails, but this is unusual.

It is common for shipboard cranes to be level luffing. This means that if the crane is topped from maximum to minimum radius, or vice versa, the crane hook will maintain a level path, allowing the load to move horizontally[72]. The power which enables the crane to hoist, luff and slew is provided by electric motors which drive hydraulic pumps. The hydraulic pumps drive the winches required for the hoisting, and drive the machinery which enables the crane to luff and slew.

Twin cranes have been fitted to some conbulk and forest product ships. The basic idea has been described[72] as extremely simple, and consists of two independent cranes of equal capacity mounted on a common platform. The common platform can be rotated independently and the cranes can be slewed relative to the platform. Each crane can be used by itself, with each serving an adjoining hold, but when a heavy lift is required the jibs are slewed parallel to one another and a lifting beam is attached between the crane hooks. This arrangement allows the lifting of loads of up to twice the safe working load of one crane. The speed of the hoisting and luffing motions of the cranes is synchronised to ensure smooth operation.

When the cranes are operated in the twin mode the individual slewing motions are inoperable and only the platform slewing motion can be used. Operation of the platform slewing motion causes the platform to rotate and with it the two cranes, with their jibs parallel, thus enabling large loads to be safely slewed.

If shipboard cranes are intended to be used with grabs, as *grabbing cranes* they are likely to be fitted with rope-operated grabs, for which the crane will be provided with two rope drums and two wire ropes, one to hold the grab and the other to open and close it. Alternatively, electro-hydraulic grabs are easy to fit to existing cranes and grabs can also be operated by remote radio control. These systems replace the simple but inefficient self-dumping grabs which are used on a single fall of wire rope.

Crane maintenance: The detailed maintenance required by cranes depends upon their construction, and must be learnt from their instruction manuals, which normally provide detailed guidance as to frequency of service, materials to use and items to inspect. The main areas which require attention are the following:

- *Daily, when cranes are being used to work cargo.*
  - * Inspect runner wires for wear or damage. Check the rig for damage and for fastenings becoming slack. Check the limit and cutout switches. Carry out oiling and greasing as necessary. Ensure the ventilation for the crane motors is open, to prevent overheating.
- *Before arrival in port.*
  - * Follow the procedures recommended by the crane manufacturers. They should include all the inspections and tests listed below for regular maintenance.
- *Regular maintenance.*
  - * The filters of the hydraulic system must be regularly cleaned or renewed and the hydraulic oil must be changed as required.
  - * The oil in the gearboxes must be kept topped up to the correct level and must be changed at the required intervals.
  - * Suitable grease must be applied to all moving parts of the system, such as the bearings of winches and sheaves, the pivot points or hinges for jib and the roller slewing ring. When the crane is required to operate regularly in temperatures below freezing greasing must be done with low temperature grease.
  - * Wire ropes should be regreased when they are visibly dry or dry to the touch, when 'bald spots' form in the grease on the outer surface, or when corrosion exists.
  - * Wire ropes must be inspected for flattening and kinking, and for broken, worn or corroded wires, and must be condemned when more than 5 per cent of the wires in any length of ten rope diameters are damaged. For example, if the wire rope has a diameter of 24 mm and is of 6 x 37 construction the total number of wires in the rope is 222, of which 5 per cent is 11. If more than 11 broken strands are found in a length of (24 x 10) mm-i.e., 240 mm-the rope must be condemned.
  - * The brakes for the hoisting winch and for the slewing and luffing machinery must be inspected for contamination with oil, for damage to the adjustments, and for wear. Where necessary they must be degreased-for example, with trichlorethylene-or the linings must be renewed.
  - * All parts of the crane must be inspected for damage and for fastenings or fittings which have become loose, worn or fractured as a consequence of blows, vibration or working in a seaway. Loose or damaged slewing ring securing bolts, for example, would seriously reduce the safe lifting capacity of the crane.
  - * Crane winch drums must be inspected to ensure that the wire ropes remain firmly attached to them. Wire must be correctly spooled on to the drum without crossing turns and the reliable operation of spooling and full drum devices and slack wire detectors must be confirmed.
  - * Deck cranes are provided with limit switches to prevent over-hoisting, over-lowering, and luffing, slewing or travelling beyond permitted limits. When a limit switch operates the crane cannot pass the limit, but still retains power to move away from the limit. Limit switches must be tested frequently to ensure that they work and that they are properly adjusted to operate in the correct position. The over-ride keys for the limit switches must be tested frequently to ensure that they work and that they are properly adjusted to operate in the correct position. The over-ride keys for the limit switches should be kept safely in the care of a responsible officer.
  - * The emergency cutout stops all power to all controls on the crane, by tripping the main electrical breaker, as soon as it is activated. The brakes on the hoisting and luffing winches are spring-loaded, and will close tight if power is lost, holding the crane and its load fixed. The emergency cutout can be activated by the crane operator and will operate automatically if there is a power failure or if the crane is overloaded. The emergency cutout is tested by hitting the cutout button, and by overloading under controlled conditions when the cranes are retested.
  - * High temperature trips and low oil level trips, if fitted, must also be checked regularly and maintained in good condition.
  - * The crane cab and machinery must be kept clean and light bulbs must be renewed. Cracked or broken windows, and plastic windows which have become dull or opaque must be renewed. The sun visor is essential to prevent the driver from being dazzled and must be maintained in good condition.
  - * Heaters for the crane are normally on a separate power circuit to that for driving the crane. They should remain switched on throughout the voyage to keep the electrical equipment for the crane warm and dry. The correct operation of cooling fans should be confirmed.
  - * The crane maintenance programme is likely to depend upon the crane operating hours, so a record of these should be kept.
  - * Electrical maintenance should include the occasional checking of all terminal screws in the switchgear cabinets, terminal boxes and on the equipment itself, and tightening them if slack.
  - * Sheaves should be inspected for damage from time to time, particularly when the crane is being used with a self dumping grab. The operation of such grabs can cause a 'ripple' in the wire rope fall, which may jump out of its own sheave and finish up in the next sheave, or jammed between two sheaves.
- *Annual thorough survey.*
  - * The annual thorough survey of a crane is carried out by a surveyor representing a statutory authority or a classification society, and the nature and extent of the survey is described in classification society publications. Besides covering all the areas listed above under 'maintenance', the structure of the crane will be carefully examined for strength with hammer testing and drilling of the material when found necessary. Sheaves may be unshipped for inspection.
  - * The cranes must be retested at four-yearly intervals, or more often if found necessary.

Operation of cranes

* The ship's officers can keep the limit switch override keys in their possession, thus ensuring that the limits cannot be overriden without their knowledge. Keys to the cabinet containing the main power breaker should also be kept by the duty officer who can then be certain that the crane cannot be restarted by an unauthorised person after it has been immobilised. It is good practice to immobilise the cranes at the end of the working day and any time that they are being maintained.

* It may be necessary to override a limit switch to stow or unstow the crane jib, or to move it to other exceptional positions whilst it is carrying no load. This

must only be done under the supervision of competent ship's personnel.

* When shore drivers are employed to drive the cranes they will require careful supervision from ships' officers to ensure that they use the ship's equipment safely, and do not damage it.
* Cranes should be driven smoothly.

Grab maintenance

Grab design: Some geared bulk carriers are equipped with their own grabs to be used with their cranes or derricks. Shipboard grabs differ in mechanical design and in the system used to control their closing and opening, but some general points can be made.

The first grabs to be widely used aboard ship with derricks or cranes were self-dumping or hand-released grabs, which operate on a single fall of wire rope. Such a grab is emptied either by pulling on a trip cord or by lowering the cargo-filled grab on to the stockpile, when the release mechanism will operate and the jaws will fall open as the grab is hoisted. However, self-dumping grabs are reported[72] to be slow in operation and unsuitable for difficult cargoes such as iron ore and rock phosphate. Some crane manufacturers state that all guarantees for their cranes become invalid if self-dumping grabs are used with them, and self-dumping grabs have been replaced by electro-hydraulic grabs and rope-operated grabs in many ports.

Electro-hydraulic grabs when used with an electric cable reel of the correct type give excellent results. Their principal advantages are reported[72] to be that they have a high payload-to-weight ratio, no shock loading occurs during closing or opening, and they are easily fitted to existing cranes.

Rope-operated grabs are likely to be fitted when grabs are part of the vessel's initial equipment. They use two winches with independent motors. One winch holds the grab stationary during the opening and closing sequence whilst the other winch pays out to open the grab and winds in to close it. When the grab is being hoisted or lowered both winches operate simultaneously. Another grab control system supplied to ships is remotely operated by radio. Ships' grabs are generally clamshell grabs, the name given to grabs with buckets of a particular shape (Fig. 23.3).

Grab capacity: The amount of cargo which a grab can lift is governed by the capacity of its bucket-that part of the grab which holds the cargo. Capacity can be measured flush, or heaped (Fig. 23.4) and a good rule of thumb is that heaped capacity is approximately equal to flush capacity plus 25 per cent. Grabs come in a variety of sizes to suit cargoes with very different densities. A grab intended to lift 5 tonnes of grain would require three times the capacity of a grab suitable for 5 tonnes of iron ore. Grabs carried aboard ship are likely to be a compromise, so if heavy cargoes are to be loaded or discharged by ship's grab, calculations must be carried out to ensure that the weight of grab plus contents will not exceed the safe working load of the ship's cargo gear.

The calculation might look like this:

Capacity of grab, flush, (from documentation, or by measurement):	2.50 cbm
Plus 25% for heaped capacity:	.63
Heaped capacity:	3.13
Intended cargo iron ore, (stowage factor 0.45 cbm/tonne), per grabload:	6.96 tonnes
Weight of grab (from documentation)	1.20
Total lift:	8.16 tonnes

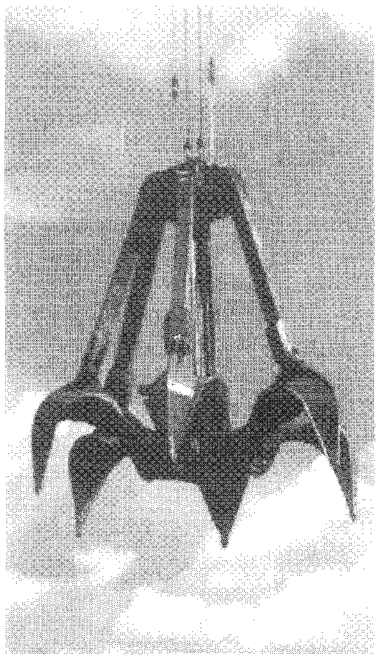
Provided that the safe working load of the ship's cargo gear is more than 8.16 tonnes and the safe working load of the grab is more than 6.96 tonnes, the system can be used to lift the iron ore.

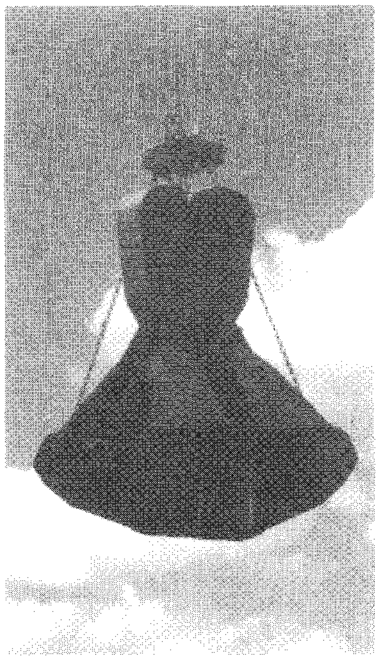
Damage to grabs: Grabs are designed for hard wear, because that is what they will meet when used for handling cargoes. They are likely to suffer damage if they are misused and practices to be avoided include the following:

- A grab which is allowed to land on a steeply sloping face of cargo will capsize, allowing the closing chains or wires to foul the grab's mechanism or structure and to be damaged.
- A grab which makes heavy contact with the ship's structure or a structure ashore is likely to be knocked out of shape, after which it will not close properly. Heavy contact of this sort is likely to be equally harmful to the ship or shore object and to the grab and should never be accepted without protest.
- When a grab is allowed to close upon the ship's frames (for example in No. 1 hold where they are close to the hatch coaming), or upon container sockets or lashing eyes in the hold, it may suffer damage to its closing mechanism or to the grab lips.

Maintenance and inspection of grabs: If grab parts such as bushes, sheaves, wire ropes or chains are to be renewed it will be necessary to unrig and dismantle the grab, partly or completely. Before doing so, full notes or plans should be made to assist with the reassembly and rerigging. Alternatively, another fully rigged grab can be used as a model if necessary.

- All the grease nipples should be found and grease should be applied frequently when the equipment is in use, and regularly at other times, following the procedures described in the general section on greasing and oiling.
- The grab may be fitted with a feature such as a dashpot, used to control the speed of opening. This reduces the violence of the grab's action and so reduces damage. A dashpot, or any similar arrangement of pistons, must have its oil level maintained with the correct clean oil according to the manufacturers' advice.
- When chains are used for opening and closing of grabs they should be lubricated with a light grade SAE 30 oil. This will penetrate to the places where the adjoining links of chain are in contact with one another, providing lubrication and reducing wear. Grease should not be used on chains, as it combines with the cargo being handled and forms a grinding paste which then grinds the chain and the sheaves away.
- Wire ropes when used for grabs should be treated with a suitable wire rope lubricant.
- Sheaves should be checked for play, and if they move





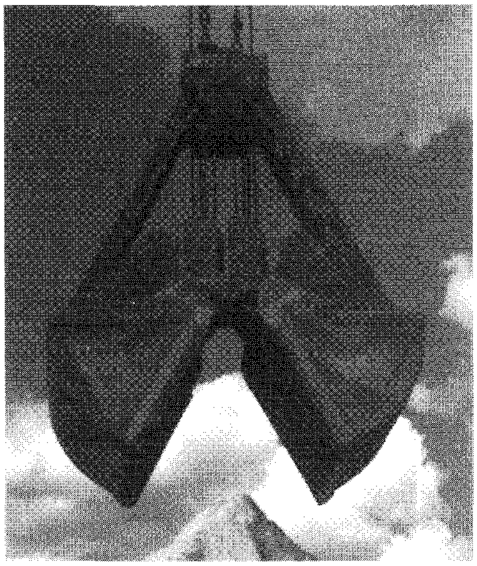


FIG 23.3 GRABS
Top left, cactus; top centre, trimming;
top right, scissor; mid left, clamshell.
Courtesy Nemag bv, Zierikzee, The Netherlands)

GRAB CAPACITY

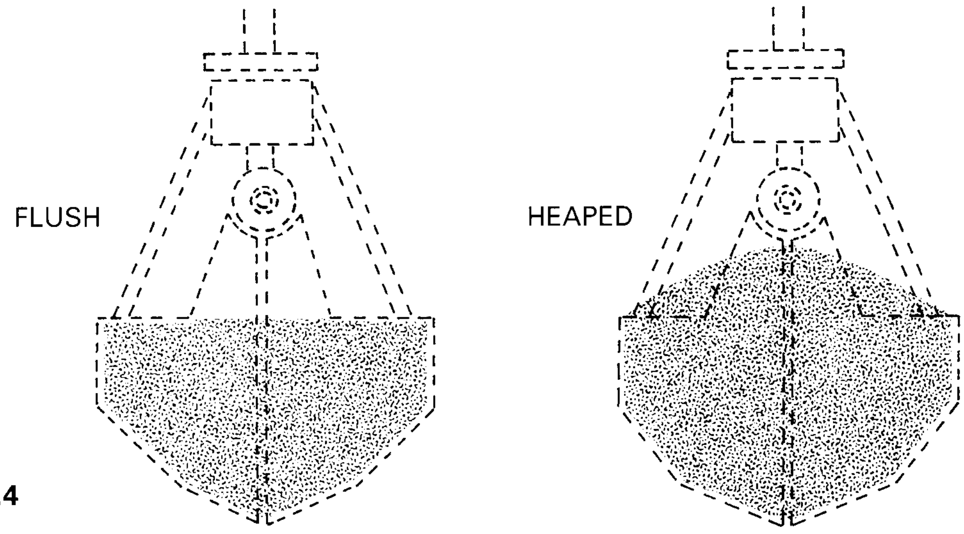


FIG 23.4

noticeably their bushes must be renewed. The working face of each chain sheave should be inspected. If grooving is found it shows that the sheave has not been turning freely. A normal wear pattern is shown when the working face has a pattern of flats and points. If sheaves are moved to different positions in the grab from time to time the wear on the working face will not become excessive. Badly worn sheaves cause damage to the chain.

- One manufacturer of chain for grabs recommends that grab chain be condemned when the diameter of the links at any point has been reduced by 15 per cent from the original value. Measurement should be made using a vernier caliper, such as the ship's engineers will have. Noticeable stretching of any of the links only occurs when they have been overloaded, and provides another reason for condemning the chain.

Maintenance of fixtures and fittings

All the fixtures and fittings found aboard a bulk carrier are liable to deteriorate. Salt water, vibration, dust and rough treatment all help to ensure that equipment will seize up, waste away or become damaged. A planned maintenance system should ensure that every item is given appropriate treatment at regular intervals. When there is no planned maintenance system the ship's officers must rely upon the systen used for centuries-commonsense, experience and practical seamanship.

Work should be undertaken methodically, trying to complete one job before starting the next and keeping a record of the work done. To prevent equipment from seizing up or wasting away it should be dismantled (taken apart) once a year or more often. The treatment needed will depend upon the item being maintained, and its condition. Paint coatings should be renewed as necessary to prevent the item from rusting and grease should be applied where needed to prevent seizing up. Damaged parts should be repaired or renewed.

The sort of maintenance which will be needed cannot be fully described within the scope of this book, but can be illustrated by reference to some of the items of equipment mentioned in Chapter 6, which described procedures for ensuring that systems are operational. The object of full maintenance is to ensure that systems *remain* operational, and to achieve this it is necessary to do rather more than simply to ensure that they are working when required. For this reason the list of jobs is more extensive than when the equipment is simply being checked before use.

The following is not a full list of the maintenance required for fixtures and fittings, but merely a selection of examples:

- To maintain hold ventilators in good condition the moving parts must be moved through their full range and greased regularly, perishable parts such as rubber seals and fire gauzes must be renewed when perished, and the steelwork which is liable to rust because of exposure to salt washing water and spray and corrosive cargo fumes must be prepared and repainted as necessary.
- To keep deck lighting in good condition every light should be opened up at regular intervals; bulbs and tubes must be renewed as required, any moving parts such as fastenings must be greased, rubber seals must be renewed when perished, broken glass covers or other causes of leakage must be renewed and wiring and conduits must be inspected. This work must be done sufficiently often to ensure that the lights are always in good condition and that lamps or tubes can be quickly renewed when necessary.
- The non-return valves in the bilge pumping system are fitted to ensure that water can be pumped from the hold bilge wells to the engineroom and overside or into a holding tank for measurement. Their second purpose is to ensure that water cannot travel in the opposite direction, *into* the hold bilge wells. The system must be tested each voyage to ensure that water can be pumped from the bilge wells, but cannot be pumped into the bilge wells. In addition, the non-return valves must be dismantled, inspected, fitted with replacements for worn or damaged parts and reassembled at regular intervals of 6-12 months.
- The maintenance of CO_2 smothering systems, fire extinguishers and liferafts is often arranged to coincide with the ship's annual inspection or survey of lifesaving equipment. The condition of the equipment must satisfy the surveyor and the required standard is often achieved by employing specialist contractors to carry out the required servicing, including the checking of gas levels in the CO_2 bottles. Annual servicing is not, of course, the limit of the attention which this equipment requires, and Chapter 6 noted the routines to be followed with this equipment. Fire extinguishers require inspection at intervals of about three months to ensure that they continue to be in good order. They should be discharged and recharged in sequence.
- Similarly, the annual freeboard inspection will prompt a careful examination of ventilators, airpipes, watertight doors, hatch covers, skylights and other deck openings. Gaskets for watertight doors, ventilators and access hatches will be renewed if badly compressed. Dogs and butterfly nuts will be greased or renewed if damaged. Floats in airpipe goosenecks must be proved operational. To ensure that the equipment remains in good order and is always able to prevent the entry of water, all the items included in the freeboard survey should receive routine maintenance at short intervals of about three months, when they will be inspected, worked, lubricated and given whatever repairs are needed.

Maintenance of hatch covers and ballast tanks: The maintenance of hatch covers is discussed in Chapter 4, and that of ballast tanks in Chapter 7.

Good *maintenance*

To remain safe and efficient a ship must be well maintained. That requires sensible spending on tools and supplies. It also requires good sense and commitment from the master and his crew. It has been possible in the foregoing pages to do no more than to show how maintenance work should be approached. The details will vary from ship to ship.

The basic rules of maintenance are:

- Be thorough.
- Be methodical.
- Plan maintenance work well in advance.
- Consult with other departments and keep them informed.
- Study the manufacturers' manuals.
- Use the correct tools and materials.

- Do not expect too much from inexperienced crew members.
- Keep full records of the work done.

Sources

68. Macleod, Captain M., MNI. 'Spare Part Control and Planned Maintenance Using Computers'. *The Nautical Institute on Command.* 1986.

69. Phipps, D. *Grab Operators Handbook.* Arlona Engineering (Pty) Ltd., New Germany, South Africa.

70. Isbester, Captain J., ExC, FNI. 'Ship and Equipment Surveys-The Master's Responsibilities'. *The Nautical Institute on Command.* 1986.

71. Foster, H. 'Marine Paint Systems and their Application'. *The Nautical Institute on Command.* 1986.

72. Beattie, D. H., and Robson, A., C.Eng. 'A Review of Cargo Handling Systems for Dry Cargo Vessels'. *Transactions of the North East Coast Institution of Engineers & Shipbuilders,* Vol.95. 1979.

73. *Code for Lifting Appliances in a Marine Environment.Lloyd's* Register of Shipping. 1981 with corrections to 1984.

74. Deck Crane Manuals from Liebherr, Germany & Hagglunds, Sweden.

CHAPTER 24

REPAIRS AND DRYDOCKING

Repair of damage and defects, drydocking

Repair of damage and defects

SHIPS, like any other structures, suffer damage and deterioration. As a consequence they need repair from time to time. This chapter does not deal with repairs within the ship's machinery spaces: such repairs are not peculiar to bulk carriers, but must be carried out in every type of vessel. The subject of this volume is bulk carriers and it is the repairs to holds, ballast tanks, hatch coamings, hatch covers, deck services, deck machinery and fittings which are the focus of this chapter.

There is a variety of ways in which repairs can be arranged. A damaged or defective item may be repaired by members of the ship's deck department, by their colleagues from the engine department, by stevedores responsible for the damage, by a repair firm hired in a port of call, by specialists from the firm which manufactured the damaged item, by a riding squad who travel with the ship, or as an item on a drydock repair list.

Discovery of damage: It should be impossible for damage and defects to go undetected for any length of time aboard a well-run ship. A system of inspections, testing and measurement should ensure that problems are discovered rapidly.

Wherever possible stevedores' damage should be detected by the duty officer as it occurs. In any event it should be found during hold inspection as discharge is ending. There are further opportunities to detect damage within the holds when cleaning is completed, and during preloading inspections. Routines to ensure that all the ship's equipment is in good order before entering port and the regular sounding of bilge wells and ballast tanks provide further opportunities for discovering defects. Routine thorough examinations of every hold and ballast tank at intervals of 6-12 months provide further occasions when damage can be found and recorded.

In addition, prudent masters and chief mates will inspect their ship very thoroughly during the first few days afterjoining her and should notice defects at that time. Such inspections are advisable because these officers need to possess a detailed knowledge of their ship if they are to perform their duties efficiently, and because defects which they do not discover enjoining may be blamed upon them at a later date! The Nautical Institute has published an inspection checklist which may be of assistance. (Appendix 24.1)

Another obvious warning of damage is received when loud noise, heavy impact or vibration is experienced. It goes without saying that any such should be investigated promptly.

Assessment of damage: When damage has occurred the first requirement is to inspect it carefully to determine its extent and cause and to consider its consequences. All damage should be inspected with care. Often damage to the ship's structure will be found to be more widespread than first appears. When an indentation caused by a grab is found in the hatch coaming it is easy to overlook the fact that the entire coaming has been bent out of true, or that coaming brackets have been buckled. A blow on the ship's side, from a tug or a fender, may be transmitted through the ship's internal structure to the hopper sides, causing damage there, remote from the location of the contact. Wherever possible damaged structures should be inspected from both sides of the plating. Inspections are best made by at least two experienced officers to reduce the chance that part of the damage will be overlooked.

When a first assessment of the damage has been made its consequences must be considered. Is the ship's seaworthiness affected? Can she continue to operate efficiently? What steps can be taken to minimise the effects of the damage? In the case of serious damage these judgements will eventually be made by specialists, but the master and officers should reach their own conclusions as the people on the spot so that they can provide a full picture when reporting damage.

If ships are to retain their class, shipowners must report to the classification society any damage or deterioration which might affect the ship's class. This is an important requirement and as a first step in observing it the master should report damage to the owners as soon as it occurs. When damage is found the master should remember this requirement. If he thinks that there is any possibility that the ship's class is affected he must report the details to the owners immediately, so that they can pass them to the classification society. Any serious damage to the ship's shell or deck plating, coamings, hatch covers or watertight bulkheads, anchors and mooring equipment, watertight openings and their fastenings will warrant an immediate report to the owners.

Repair documents: When the ship and the ship operator are well organised there will be a system for the recording and reporting of damage and deterioration. An efficient system will: provide a record of every defect, give full details of the repair required, provide the basis for a drydock repair list any time when required, inform ship operators of the item, and record when the defect has been repaired. One such system uses a set of four self-carbonating forms. To provide a full record of repairs a copy of the form should be completed for every defect, whether the repair has been completed, or remains to be done.

There are several reasons why it is important for head office to have a record of all the ship's defects. A knowledge of items which have suffered damage or failed will help the ship's management to monitor the ship's condition and may provide early warning of similar problems with sister ships. When repairs have been completed by ship's staff it is still important to report that the damage occurred, and the report will ensure that the work of the crew in making the repair will be known and appreciated and the charterers or responsible party will be charged.

It is essential for the management to know of unrepaired defects so that they can be sure that repairs are given the priority they require. A further reason why reports of all defects should be sent promptly to head office is that orders for drydocking are sometimes given quite unexpectedly as the result of a complete change of orders or of serious damage from collision or grounding. In these circumstances drydock repair lists must be compiled very rapidly and this is much easier to do when all the details are up to date and immediately to hand.

Reports of defects when made by word of mouth, whether by telephone or face to face, may be forgotten, ignored or overlooked. The completion of a repair form will ensure that the report of the damage remains on record and is considered from time to time. One copy of the form will be retained by the originator-the person aboard ship who completes it. A second copy must be sent to the ship manager at head office at the first opportunity. The third copy may be retained to give to a local contractor if the repair is arranged locally. Additional copies may be required by the company's insurance or accounts departments.

Completion of the repair specification. The repair specification form will normally call for the details which are needed to arrange for the repair, and to estimate a price for it. It is impossible to design a form which anticipates the details of every item needing repair, and ships' officers must give thought to ensuring that all the information needed to plan the job and to price it is provided.

The position of the item requiring repair must be carefully and accurately described with reference to a recognisable feature such as a hold number, port or starboard side, and direction and distance in metres, or number of frames, from an identifiable feature. (Additionally the actual position on the ship should be marked with the damage report or drydock repair number, using paint or felt-tipped pen.) It often happens that when the time comes to make the repair the person who wrote the item will have left the ship and no-one will be familiar with it. This makes it essential that sufficient information is given to identify the item for repair.

Dimensions of the damage and of the steelwork or other material damaged must be given accurately or must be labelled 'approximate' in case replacement parts are to be prefabricated. Difficulties of access-difficulties which will be experienced by workmen when required to reach the damage-must be fully explained as this will influence the method of repair and its cost. If the ship has replacement parts aboard and is able to provide the parts needed for the repair, this should be stated. Any need for staging must be stated so that due allowance can be made for this expensive item. If the damage is stevedores' damage or damage sustained in any incident which has been the subject of a report this should be shown on the repair specification.

Arranging for the repair: This chief mate will normally make the first decision as to who is to make the repair and when and how it is to be done. Minor items of repair, such as the renewal of parts for hatch cover fastenings or cargo gear, will be completed as routine maintenance by the deck department and do not need to be reported in a repair specification.

Stevedores' damage should where possible always be repaired by the stevedores in the port where the damage occurred, and the chief mate (supported if necessary by the master) will try to ensure that this is done. The first step is to bring the damage to the attention of the stevedore foreman as soon as it is seen or found, and this must be followed immediately by a written stevedores' damage report, providing details of the damage and how it occurred, and holding the stevedores responsible for making good the damage. Standard forms for this purpose are provided by most owners and charterers (Appendix 3.1). The form should be given to the stevedore foreman and his signature obtained to acknowledge responsibility or, failing that, to acknowledge receipt of the document.

In some circumstances a temporary repair is appropriate. Temporary repairs may take the form of a steel doubling plate welded over damaged steelwork to prevent leaking, or of a cement box, also usually used to prevent leaking. Such repairs do not return the structure to its former undamaged strength and watertightness and the item which has been temporarily repaired will be listed for a permanent repair at the next drydocking, or sooner. For more expensive and complicated damage the chief mate will normally consult the chief engineer and master and enquiries may be referred to the ship's manager or superintendent.

Provided that the ship's staff have the necessary skill, tools, materials and time it is always best for the repairs to be completed by ship's personnel, since this will normally be the cheapest and most efficient alternative. When the ship is at sea or in a remote anchorage or port there is often no alternative to repair by ship's staff.

It should be obvious, but is worth stating, that efficient repairs of deck equipment and fittings by the ship's engineers are most likely to be achieved when there are good working relations between departments. These are most likely to exist when each department keeps the other informed of problems and when the advice of the engineers on the maintenance and operation of mechanical equipment is heard with attention. The training of engineers normally ensures that they have a good knowledge of the principles of using and caring for machinery. This is much less certain in the case of deck ratings and officers: those who have an interest in their work can learn a lot from their engineer colleagues.

When repairs cannot be done by stevedores or ship's staff a decision must be taken as to the best way of obtaining assistance from ashore. This is a decision which the master and his senior officers are authorised to take on some ships, whilst on others they must refer the problem to the shore-based management. The decision whether to use a local repair firm, a specialist firm or a riding squad to make the repair or to add the item to the drydock list will be influenced by a number of factors. If the ship cannot operate safely until the repair has been completed the work must be done immediately: a major repair to the hatch covers such as the repair of damaged hinges for folding hatch covers would come in this category and would be best done in consultation with the manufacturers. A defect which affects the ship's efficiency or incurs time off-hire, such as a damaged crane, will be repaired as soon as parts and labour can be arranged at an economic price. The more urgently the crane is needed the higher the price which it is worth paying for repairs.

Use of a local repair firm in the port where the ship lies will be a sensible option when urgent work must be done and the ship lacks the equipment, the time or the expertise. This option will be chosen from time to time.

There is a role, too, for riding squads: workers who are contracted to travel with the ship for a period of days or weeks to complete particular items of work. Riding squads may be employees of the shipowner who move from ship to ship within the fleet doing particular work or they may work for repair firms. The benefit of employing a riding squad is that it supplements the ship's work force and can undertake work which the ship's crew do not have the time and/or the expertise to carry out efficiently. If brought aboard at suitable times they can work in favourable conditions, without delaying the ship. Riding squads have been used for jobs such as the renewal of the rubbers in steel hatch covers and the renewal of a ship's deck hydraulic pipework. Such work is usually best done on a ballast voyage when the decks are dry and there is no possibility that a mistake can result in damage to the cargo. They offer a useful solution when there is a major maintenance/repair problem.

When the damage reduces the vessel's value but has little or no effect upon her safety and efficiency, repair is likely to be deferred until the next drydocking. Indentations in the vessel's shell plating sustained from contact with tugs, fenders and dock walls come into this category, as does minor stevedores' damage. Steelwork which has been weakened by wasting is normally renewed in drydock unless it is clear that the need for renewal is so urgent that it cannot be deferred until then. In drydock full repair facilities are available and repair work can usually be done more cheaply.

Supervision of repairs: Defects are a source of worry and inconvenience for those who serve on ships and it is a great relief when the time comes for damage to be made good. The time for celebration, however, comes only when the repairs have been successfully completed. If repair work is not properly supervised there will be plenty of opportunities for mistakes to be made.

It is unwise to assume that repair workers are fully informed, trained in safety procedures, competent in the work they have been given and committed to doing a faultless job. They may be, but it would be a great mistake to rely upon it. The ship's officers should be familiar with the details of the repair which is being undertaken. An officer should be present when the work is commenced to ensure that the right place is found and that conditions are safe for the work to start. The correct repair materials must be used. Special welding rods, for example, are required for the welding of special steels, and this is a fact which could be easily overlooked by a stevedores' repair squad.

The work should be inspected from time to time as it proceeds. Often workers who are having difficulties will say so quite openly. Even an officer who is not an expert in repair techniques can detect when the work is not going according to plan and can obtain expert advice. A messy, irregular repair gives warning that the repairer is incompetent, or is having difficulties.

When a repair has been completed it should be inspected. Where possible it should be tested. Moving equipment should be operated to ensure that it runs smoothly as required. Watertight features should be tested by filling the compartment or by hose testing, as appropriate. When the repair is permanent and has been completed satisfactorily, the repair specification should be cancelled and the owners should be informed that the item in question can be deleted from the repair list.

Drydocking

The routine drydocking of a bulk carrier is an event which occurs seldom. Depending upon company policy and classification society rules it may be planned to occur only once every two-and-a-half years. Drydocking presents the best opportunity for completion of many of the repairs and renewals and much of the maintenance which the ship requires to keep her at a high level of efficiency. This makes it essential that drydocking work is planned well in advance.

If major work and expenditure is required such as, for example, the grit blasting and recoating of holds, the rerubbering of hatch covers or the extensive renewal of deck hydraulic piping, then head office should be warned of the requirement a long time in advance. Major work of this sort will require the allocation of funds and may affect the decision as to which shipyard is to be used for the docking and the number of days required.

The best way to inform head office of each item of work needed is by completion of a repair specification form. With major work there is little purpose in the chief mate or master attempting to specify the quality of grit blasting they require or the specification of replacement rubber for the hatches. Before the job is finally agreed experts will decide upon the appropriate materials. The chief mate should content himself with stating the requirement in general terms and giving as much information as he reasonably can-for example, the area to be grit blasted or the number of hatch panels requiring renewal of rubbers.

In addition to ensuring that repair specifications are submitted for major items of expenditure, the master and his officers should continue to submit forms for all minor defects, including stevedores' damage, so that head office has at all times an up-to-date record of defects which can be used for compiling the drydock specification. Preparation of the next drydock repair list should commence in this manner from the moment that the vessel leaves drydock.

The procedures associated with the planning and supervision of a drydocking have been well described from the viewpoint of a shipmanager[75] and it is not intended to repeat that description here. The preparations which the ship's staff should make for the docking can usefully be considered.

- Defects will continue to be found and damage to occur right up to the time of docking. Oficers must continue to complete repair specifications and to submit them for inclusion in supplementary repair lists. The master should retain copies to hand direct to the owner's repair manager, who may not have received copies through the normal channels during the last hectic days before the docking.

- The draft and trim required for the docking should be confirmed and the chief mate must ensure that the required condition can be achieved. The ship's stability must be checked to confirm that the ship will remain stable during the critical period-that period of time which starts when the stern lands on the blocks and ends when she takes the blocks overall. (Appendix 20.7)

- When the drydock has been chosen the master should consider what can usefully be arranged during the drydock period. It may be found that the period in drydock offers a convenient opportunity for other repairs, renewals or servicing of equipment which are sometimes difficult to arrange during a short stay in port.

- Confirmation should be obtained that the ship's crewwill be allowed to carry out maintenance work during the period in drydock and a list of crew work should be compiled. Jobs which are difficult to do during a normal voyage, such as recoating the fresh water tanks and painting the undersides of the hatch covers, should be given high priority.

- The master and his senior officers should give consideration to what services are to be maintained in drydock and how this is to be achieved. If the ship's generators are to be used they will need cooling water drawn from a suitable ballast tank and then returned to it. Will water for coooking and washing be available? Can toilets discharging into the ship's sanitary tank be used or must facilities ashore be provided? Can heating, ventilation or air conditioning be maintained? What fire fighting services can be maintained? Will fire and emergency alarm systems remain in operation? Will power be available for manoeuvring hatch covers and driving the deck machinery? If disruptions to services are anticipated the ship's company should be informed and alternative arrangements should be made.

- When ship's staff are to use shore toilet and washing facilities the master should seek the earliest opportunity to inspect them, and ensure that they are adequate, since it is not always that such facilities are of an acceptable standard and conveniently situated. If necessary portable units should be placed on deck.

- The period during which the vessel enters the drydock and takes the blocks must be controlled and monitored with great care to avoid accidents which could cause damage to the ship or the drydock. As soon as the vessel has taken the blocks a full accurate and complete set of soundings must be taken to provide a record of the contents of every tank and to provide the information to enable the ship to be refloated in exactly the same condition as when she was docked.

- A ship is at greater risk of fire or other accident during her time in drydock, because of the repair work being progressed, the temporary cabling which prevent the closing of doors, the additional people aboard ship and the disruption to safety routines and services. Ship's personnel should be alert for problems and should insist upon the observance of safe working practices. For example, openings must be fenced off. Enclosed spaces must be certified gas free before they are entered. Welding and burning must only be permitted when fire fighting equipment is ready and when any bulkheads subjected to heat have been checked on both sides. It should always be clear to ship's personnel whether they or the shipyard are responsible for safety patrols.

- The master continues to be responsible for the safety of the ship and personnel whilst the ship is in drydock. He should maintain a checklist of special precautions required and used.

- If any ballast tanks must be emptied after the vessel enters drydock their refilling must be started in good time to achieve completion before refloating. All ballasting and deballasting must be co-ordinated with the dock manager, particularly when the vessel is in a floating dock.

- Officers must be provided with copies of the repair list and must be made familiar with all the work to be done. The details of how this is arranged will depend upon the methods of work adopted by the owner's superintendent, the shipyard and the shipowner. To ensure that he and his officers are kept informed of all the work which is being put in hand and progressed the master will have to be ready to insist, if necessary, upon daily progress meetings attended by the owner's superintendent and the shipyard manager. Good relations must be maintained with the superintendent and the manager to ensure that the work is well co-ordinated.

- The repair list should be rechecked by the master and his officers to ensure that no items have been omitted from it by oversight and it should be monitored during the time in drydock to ensure that no work is forgotten.

- Each item on the repair list must be inspected when work on it is started, viewed from time to time whilst the repair is in progress, and inspected and tested on completion, following the guidelines given above.

- Officers may also be given responsibility for monitoring the hours worked by shipyard staff and for keeping track of ship's special equipment and tools used by the shipyard.

- When the time of undocking is approaching the master and officers should focus their attention on ensuring that the sites of the repairs are all properly cleared up, with all rubbish and equipment removed from ballast tanks, cofferdams and other spaces before they are closed. Manhole doors and other openings which have been closed should where possible be tested for watertightness.

- The chief mate will be required to recalculate the ship's stability and to ensure that the ship has been returned to exactly the same condition of loading as when she entered the drydock. With the agreement of all parties, some amendment to the contents of tanks can be accepted provided that they will affect only draft and trim. Any amendment to the athwartship distribution of weight is unacceptable: the ship must be upright and unlisted when she refloats. If she lists there is a danger that she will cause the blocks and sidebeds to tip over, which could incur considerable expense.

- Before the reflooding of the drydock commences one or more senior officers should tour the dock bottom with a representative of the yard to confirm that all the bottom plugs removed for the draining of tanks have been refitted and that all sea suctions have been correctly reassembled. They should also confirm that the rudder and propeller are clear.

- The ship's company should be at a high standard of readiness during the reflooding of the dock and the refloating to deal with any unexpected problem as it emerges. When the vessel has refloated a new set of soundings will be taken to see if any unexpected results are obtained. There have been many cases of problems arising aboard ship in the hours and days following a drydocking as a result of poor or slipshod workmanship, and prudent members of the ship's company will remain alert for anything unusual for some days after the ship's departure from drydock.

- Resume the completion of repair specifications immediately upon departure from drydock, so that an up-to-date record of defects is always ready.

Drydock repairs for bulk carriers: Much of the work for which bulk carriers are drydocked is no different from the work done on other classes of ship. Inspection, repairs and renewals of rudder, propeller, anchors and cables, overhaul of ship's side valves and overside discharges, cleaning of the ship's hull, recoating of the shell plating, renewal of cathodic protection and recutting and remarking of leadlines and draft marks are all tasks performed on any ship which is drydocked.

Within the holds the repair of stevedores' damage is likely to be a substantial item and the repair of stress fractures in side shell frames, welds and brackets will be undertaken if fractures are found. Steelwork, typically in holds and ballast tanks, which has become wasted and weakened by excessive corrosion will be renewed. Drydocking provides an opportunity for heavy deposits of sediment to be washed out of ballast tanks through holes cut in the ship's bottom but alternative methods of sediment removal, described in Chapter 8, may be preferred.

Major repairs of deck hydraulic pipework, often needed when ships are about eight-ten years old, can be completed in drydock as can renewals of hatch rubbers though this work can sometimes be done more economically or conveniently by a riding squad when the ship is on a ballast voyage.

Sources

75. Hutchinson J. L., C.Eng, MIMarE. 'Planning a Dry Dock.' *The Nautical Institute on Command.* 1986.

200. 'Substandard Ships & the Shipmaster.' NI Substandard Ship Working Group. *Seaways.* February 1990.

CHECKLIST-The repair of damage and defects

- ☐ To discover damage and defects carry out regular inspections on joining the ship, before entering port, on completion of discharge, after cleaning holds, on a regular annual basis and at any other time when damage may have occurred.
- ☐ Inspect damage and defects carefully to note full extent.
- ☐ Does ship remain seaworthy and efficient?
- ☐ Report serious damage immediately to the shipowner, who will inform the classification society if necessary.
- ☐ Report minor damage routinely to the shipowner.
- ☐ Reports should be made or confirmed in writing, preferably using a standard defect report and repair specification form.
- ☐ A repair specification should be completed for every defect.
- ☐ Repair specifications should be completed carefully with full details, including access.
- ☐ When they have the time and when they possess the skill, tools and materials repairs should be done by ship's staff.
- ☐ Stevedores' damage should be brought immediately to the attention of stevedores and repaired by them before the ship leaves the port.
- ☐ Temporary repairs of damage may be appropriate.
- ☐ For advice regarding larger repairs the chief mate should consult the master, chief engineer and ship manager.
- ☐ Repairs can be done by equipment manufacturers, local repair firms, riding squads and drydocks.
- ☐ Repair work should be carefully supervised by ship's staff to ensure that it is done safely and correctly.
- ☐ Completed repairs should be inspected and tested where possible.
- ☐ There should be a procedure for informing owners when a defect has been repaired, and it should be used.

CHECKLIST-Reminders for drydocking

- ☐ Drydocking happens infrequently: every effort must be made to take full advantage of the opportunities it offers.
- ☐ Start reporting defects as soon as the ship leaves drydock, so that data for a repair specification are always ready.
- ☐ Write repair specifications for big and expensive jobs at least a year in advance, so that plans and finance can be arranged.
- ☐ Continue reporting new defects right up to the date of entering drydock.
- ☐ Calculate a stable condition of loading for entering drydock.
- ☐ Take advantage of extended drydocking period in port to arrange for other necessary repairs and services.
- ☐ Prepare a worklist of suitable work for the ship's crew.
- ☐ Consult to find what shipboard services will continue to be available in drydock and make appropriate plans.
- ☐ Prepare a safety checklist.
- ☐ Ensure that shore facilities for ship's staff are adequate.
- ☐ Carefully monitor the docking and record tank contents.
- ☐ Ensure that safety is maintained during time in drydock.
- ☐ Establish effective daily consultation with superintendent and yard manager.
- ☐ Ensure no work is forgotten or dropped from list by mistake.
- ☐ Officers are to monitor and inspect all work and test it on completion.
- ☐ Records of hours worked by dock staff to be kept if required and check to be kept on specialist tools lent.
- ☐ All work areas to be cleaned and closed on completion of work and watertight closing to be tested when applicable.
- ☐ Stability to be recalculated to ensure vessel will refloat upright.
- ☐ Inspect to confirm that bottom plugs and sea suctions are refitted, rudder and propeller are clear, and other external work is complete before refloating.
- ☐ Be alert for problems during refloating and for some time thereafter.
- ☐ Resume reporting defects when the ship leaves drydock, so that data for a repair specification are always ready.

CHAPTER 25

SHIP'S HOUSEKEEPING

The housekeeping problem, excluding dust, dealing with dirt, keeping water out, disposal of wastes

Housekeeping problem

A BULK CARRIER operates most efficiently and is most pleasant to live in when dust, dirt, seawater, ice and snow are kept out of the accommodation, machinery spaces and storerooms, but this is not easy to achieve. A laden bulk carrier has a small freeboard and her decks are frequently awash, providing opportunities for sea water to enter holds and storerooms.

Bulk cargoes are often dusty and their loading or discharge spreads dust and dirt over a wide area which can include the entire ship. Bulk terminals are sometimes filthy, with the approaches to the ship covered to a depth of several inches in wet cargo residues. Certain cargoes-such as alumina and quartzite, for example-produce dust which is very abrasive and must be kept out of machinery.

Excluding dust

Alumina is a fine white powder with highly abrasive qualities. It is extremely dusty and liable to cover the ship overall during loading and discharging operations. Besides overall contamination of accommodation and other spaces, severe damage can be caused by this cargo dust to engineroom and deck machinery, radio and navigation equipment. The precautions recommended by one shipowner for excluding alumina dust are given below. These are extreme precautions for a particularly damaging type of dust: the same precautions can be used, as far as is necessary, for other less harmful dust.

- All accommodation and engineroom intake fans must be switched off.
- All intake vents must be screened with a double layer of muslin.
- All fire flaps must be closed.
- All exposed deck motors (e.g. hatch, windlass, capstan, crane, gangway, lifeboat) must be covered.
- All doors, skylights, ports and windows in accommodation, engineroom, cranes, deck stores and other spaces must be closed.
- All exposed navigation aids (e.g., radar scanner, satcom aerial) must be protected.
- Air conditioning must be recirculating with outside vents shut.
- Hold bilges must be made 'siftproof by covering them with double burlap sealed with ramnek tape around the edges.
- Any hatches which are not being worked must be kept closed, thereby avoiding unnecessary exposure of the rubber packing and blockage of the drain holes. Trackways must be scrupulously cleaned upon completion.
- The hatches on enclosed lifeboats must be sealed with masking tape and open lifeboats must be covered.
- If the instruction books for auxiliary machinery contain advice for running in contaminated areas-for example, if they advise the use of fine air filters or more frequent oil changes-these instructions must be followed.

Precautions of this sort require time and organisation to put in place and to remove. It is necessary for the master and mates to keep other members of the ship's company fully informed to ensure that the precautions are put in place in good time and are not removed until the exposure to dust is ended.

Dealing with dirt

Dirt in the accommodation: Dirt is to be found on the dockside of many bulk carrier berths and is spilt on the decks of bulk carriers by the loading and discharging operations. It is brought into the accommodation on the boots and clothing of ship's crew, stevedores, officials and other visitors if they are not prevented from so doing.

Most of the people who enter the accommodation, both ship's company and visitors, understand the wish to keep the accommodation clean and are prepared to be co-operative. To gain their co-operation it is necessary to make co-operation easy, to provide whatever facilities are needed, and to show clearly what is required. It is useless to post a notice saying 'Clean your boots before entering' if nothing is provided for cleaning boots. Such a notice is equally useless if those entering cannot read English: the best notices use pictures to pass the message.

Most people who enter the accommodation do so through the door which is nearest to the gangway or accommodation ladder. Some bulkers provide a fixed steel scraping bar outside each of these doors to be used for scraping dirt from footwear. Some bulkers also have broom heads with stiff bristles fixed in position to one side of the door to be used for brushing dirt from boots before entering the accommodation.

Inside all accommodation doors the use of check-mats can be recommended. These are rubber-backed mats measuring about 2.0 x 1.3 metres and having a loose pile which soaks up dirt. They can be washed in a heavy-duty domestic washing machine or scrubbed on deck using a portable high-pressure Kew gun and hose, and will dry in a few hours if hung in a warm dry place. If spare mats are carried the dirty mats can be removed daily for washing whilst the ship is in port.

Aboard some bulkers everyone entering the accommodation or some part of it is asked to remove his shoes. Those entering will be very reluctant to comply with this request unless the deck covering is very clean indeed. One major owner of bulkers has adopted an effective way of dealing with this problem.

As people enter the accommodation block they see a notice which invites them to help keep the accommodation clean by wearing the overshoes provided. Two boxes of plastic/fibre overshoes are situated by the entrance. One box contains new unused overshoes, while the other contains used overshoes. These overshoes cost about $1 a pair, and are obtainable from British and European shipchandlers. Provision of overshoes has greatly reduced the amount of dirt being walked into the accommodation. Japanese ship operators achieve a similar result by providing slippers for visitors to wear.

Dirty clothing in the accommodation presents problems unless changing rooms and lockers are available so that all those entering can be persuaded to remove outer clothing for the time they are inside. When a ship is provided with a cargo control room or ship's office close to the main accommodation entrances, movement between the open decks and the control room in dirty clothing is difficult to avoid, but stricter standards can be imposed on anyone needing to pass further into the accommodation, particularly to carpeted areas. A higher standard of cleanliness can be demanded of visitors to cabins and to the master's office.

When conditions on deck are dirty there is much to be gained by allowing access to the accommodation through one door only, with other doors closed and locked from the inside. This has the added benefit of improving the ship's security.

Dirt on deck: For the purposes of these notes dirt on deck includes cargo spillages, hold and bilge sweepings, leaking hydraulic oil and snow and ice. When these substances are to be found on deck officers must consider the danger of people slipping, the possibilities of pollution of dock water, and the likelihood that the substances will be carried into the accommodation on people's shoes.

Where possible trimmers should sweep up and remove cargo spilt on deck, but in many ports they do not accept this as part of their work. If such work is left to the crew the quickest and easiest method of cleaning is usually to hose down the decks, washing the residues into the sea after the vessel has left port. That is acceptable provided that the decks do not become unsafe in the meantime, provided that much dirt is not walked into the accommodation and provided that discharge of cargo residues is permitted. Cargo is usually spilt only on one side of the deck, unless exceptionally the ship is working cargo on both sides, so the side which is not in use besides being safer for anyone needing to walk along the deck is also cleaner. If the decks are unsafe because of cargo residues, safe pathways must be swept or shovelled clean.

Hold and bilge sweepings when stored on deck before disposal should be stacked in positions which do not interfere with free passage along the length of the deck. It is sometimes convenient to pile sweepings in the sheltered positions between adjacent hatches, damped down to prevent dust from blowing about and covered if possible with plastic sheeting.

Leakage of oil from hydraulic systems should never be allowed to lie on deck. Leakage gives the ship a neglected appearance, makes the deck slippery and hazardous and presents a pollution risk since the oil could drain overboard or be washed over by an overflow of ballast or a downpour of rain. Oil leaks should be repaired as soon as they occur, and the spillage should be cleaned up. Oil absorbent granules are better than sawdust for the removal of spillages, and oil absorbent mats are excellent as a temporary means of soaking up minor leakage.

Snow or ice which lies on deck is a hazard for those who have to walk over the decks. It should be shovelled to one side, melted with rock salt or sprinkled with sand or grit to ensure that a safe non-slip surface is available.

Keeping water out

Sea water which enters storerooms, accommodation, machinery or cargo spaces can cause considerable damage to the contents of the space it has entered. Several of the methods of excluding water have been mentioned in previous chapters, but it may be useful to consider them together.

Water in the forecastle space: Water in the forecastle store can destroy the switchgear and motors for the windlasses, hatch opening units and other electric equipment. Stores placed in the space can also be destroyed, and corrosion of the space and its contents will increase. Water can enter the forecastle space by any of the following routes.

- Through watertight doors or hatches which have been left open or carelessly closed or which have defective seals or cleats.
- By leakage from a flooded chainlocker.
- By leakage from the deck service/cable washing line.
- Through drains with caps missing in forecastle bulkheads.
- Through a ventilator which has been damaged or left open.
- By flooding from the forepeak tank by way of a loose or open manhole cover or an open sounding pipe.
- Through fractures in the structure of the compartment, most likely to be found around the hawse pipes or in way of contact damage.

The measures required to prevent flooding are the following:

- Keep watertight doors and hatches well maintained with good rubbers and efficient cleats. Make sure they are properly and completely closed at the end of the working day, and when rough weather is expected. Tighten dogs regularly in heavy weather, as they frequentiy ease back.
- Fit portable covers over the spurling pipes when the ship is at sea to prevent sea water washing into the chain lockers. Keep the chain locker doors closed when the ship is at sea. Sound the chain lockers daily and pump them out whenever water is found in them.
- The valves for the washers for the anchor cables should be closed when the washers are not in use.
- Bulkhead drains should always be properly capped or plugged when not in use.
- Ventilators should be carefully closed when bad weather is expected.
- The manhole cover for the forepeak tank should, if it has been opened, be closed and secured before the tank is completely filled and the sounding pipe cap should be left screwed shut.

- Any signs of leakage after washing down, heavy rain or meeting heavy weather should be carefully investigated.
- The high-level bilge alarm, if fitted in the forecastle space, should be tested whenever the ship leaves port and weekly at sea.
- The forecastle space should be inspected daily in rough weather and promptly whenever the high-level bilge alarm sounds.

Water in masthouses, deck stores and accommodation: Masthouses, deck stores and accommodation are not intended to contain sea water and it must be excluded by keeping watertight doors, deadlights and ventilators in good operating condition and by ensuring that they are properly closed before the onset of bad weather. Bulkhead drain plugs, when fitted, must be properly capped or plugged when not in use.

The poop deck on all but the smallest bulkers is usually free of water, so doors there are sometimes carelessly left unsecured. On those rare occasions when the vessel is experiencing a high following swell water may be shipped on the poop deck. When that is a possibility the poop deck should be well secured.

Water in holds: Water can leak into holds through the hatch covers, through leaks in the deck or the ship's sides, from ballast tanks, down ventilators, through damaged airpipes or uncapped bilge sounding pipes, and through bilge suction, bilge eductor or ballast lines. Leakage can only occur when the ship or her fittings are defective or misused. Leakage into holds can damage cargoes and even lead to the sinking of ships.

Leakage can usually be detected by a rise in the ship's soundings or by the setting off of high-level bilge alarms, when fitted. When holds are empty leaks can be seen. Leakage is prevented by ensuring that the ship's structure is sound and undamaged and that all her fittings are properly maintained, regularly tested and correctly used.

Disposal of wastes

The international regulations which govern the prevention of pollution are the IMO Marpol 73/78 Regulations[93] which deal with pollution by oil, noxious liquids, harmful substances in packaged form, sewage and garbage. All these regulations apply to dry bulk carriers where appropriate. The regulations which affect bulkers in their day to day operations are those concerning pollution by oil, sewage and garbage.

The following paragraphs contain a simplified summary of the main provisions of the regulations, as they applied to bulk carriers of more than 400 tons gross in 1991. The regulations themselves should always be consulted to ensure that any disposal of waste complies.

Oily wastes: The oily wastes produced by bulk carriers occur in the ship's machinery spaces. Such wastes usually collect in the machinery space bilges, and become mixed with water. The discharge of unseparated oily wastes from bilges into the sea anywhere in the world is prohibited.

To comply with the regulations a bulk carrier is normally fitted with an oily water separator which extracts the water from the oily mixture. The waste oil which remains after separation cannot be put into the sea and must either be burned in the ship's incinerator if she is so equipped, or pumped ashore direct to reception facilities at the berth or, more commonly, to a road tanker which will take the waste oil for disposal ashore.

The water which has been separated from the oil may still contain some traces of oil. It can be discharged into the sea, but only under carefully controlled conditions. *Water containing traces of oil can be discharged into the sea only when:* the ship is not within a Special Area, the ship is more than 12 miles from land, the ship is proceeding *en route,* the oil content of the discharge does not exceed 100 parts per million (ppm), and the ship is using an approved oily-water separator system.

Within a Special Area more stringent regulations apply. *Water containing traces of oil can be discharged into the sea within a Special Area only when:* the ship is proceeding *en route,* the oil content of the discharge does not exceed 15 ppm, and the ship is using an approved oily-water separator system.

Special Areas: Special Areas in 1991, for the purposes of discharge of oily water, were the Mediterranean, Baltic, Black Sea, Red Sea, the (Arabian) Gulfs Area, the Gulf of Aden and the Antarctic. Full records of all activities involving oil or oily water must be recorded in the ship's *Oil Record Book.*

Sewage: Annex IV of the Marpol regulations is concerned with the discharge of sewage. It contains three levels of restriction on discharges, depending upon the effectiveness of the ship's equipment.

1. There are no restrictions upon discharge from a ship which has an approved, certified sewage treatment plant which produces a colourless, undetectable discharge.
2. When the ship discharges sewage which has been disinfected and reduced to small particles such discharge is permitted at a low discharge rate and at distances greater than 4 miles from land whilst the ship is proceeding *en route.*
3. Discharges of sewage which do not comply with Options 1. or 2. are permitted only at distances of more than 12 miles from land at a low discharge rate and whilst the ship is proceeding *en route.*

In 1992 the Marpol sewage regulations were not yet in force. They have been adopted by a number of the major maritime nations, but other countries may impose less stringent requirements.

Garbage, cargo residues and associated wastes: Annex V of the Marpol Regulations is concerned with the disposal of garbage. The annex makes no reference to the disposal of cargo residues, but the *Guidelines for the Implementation of the Annex* state that cargo residues (i.e., small quantities of cargo spilt on deck and of cargo remaining in the holds after discharge) are to be treated as garbage. Cargo associated wastes (i.e., separation materials, dunnage and lashing materials associated with the carriage of cargo) should also be treated as garbage.

In summary, the rules for the disposal of garbage, including cargo residues and associated wastes, are as follows:

- Whenever possible garbage, cargo residues and waste should be landed to shore reception facilities.
- Plastics and harmful substances must never be put into the sea. Harmful substances are those which can harm human health, living resources and marine life, damage amenities or interfere with other legitimate uses of the sea.
- No garbage, cargo residues or wastes are to be put overboard in Special Areas when sufficient shore reception facilities are available. The Special Areas which met this requirement in 1992 are the Baltic and North Seas, and the Antarctic. Other Special Areas where this prohibition cannot yet be applied are the Mediterranean, the Black Sea, the Red Sea, the Gulf and the Caribbean.
- Cargo associated wastes which will float-e.g., dunnage, linings and packagings-can be put overboard at sea provided that: they are put overboard as far from land as possible, they are not put overboard within 25 miles of land, they are not put overboard in an established Special Area.
- Garbage, and cargo residues or wastes which will not float can be put overboard at sea provided that: they are put overboard as far from land as possible, they are not put overboard within 12 miles of land (if this garbage has been ground very small [comminuted] the minimum distance is 3 miles from land), they are not put overboard in an established Special Area.
- With the exception of food wastes no garbage and cargo residues or wastes can be put overboard in established Special Areas. Food wastes can be put overboard in Special Areas when the ship is not within 12 miles of land.

Putting waste overboard at sea: To avoid mistakes, safe procedures must be followed when putting waste overboard at sea and the following are recommended:

- The waste must be sorted into (a) plastic, (b) food wastes and (c) bottles, cans and paper. Plastic can never be put into the sea. Waste is best sorted by having separate bins in the galley for each type of waste.
- The person responsible for putting the waste overboard should contact the ship's bridge at a regular time each day for permission to put waste overboard. The type of waste must be stated.
- Permission should only be given when the ship's position is suitable.
- A full record should be kept of each occasion that waste is put overboard.

Compacting: When the ship has a compactor it can be used to reduce the volume of waste by as much as 12:1. Compacted waste, if put overboard, will sink much more readily and if stored on board will occupy much less space.

Incineration: Disposal of domestic waste in a ship's incinerator is simpler than putting waste overboard as there is no need to sort the waste first. For that reason some ships favour disposal of all waste by incineration. Ashes from the incinerator probably amount to no more than 20 litres/week and should be retained for landing, particularly if they include ashes from the burning of sludge.

Putting waste ashore: Receipts should be obtained for any waste which is put ashore as authorities may require evidence of the manner in which the ship disposes of her waste. Some countries with strict agricultural regulations will not accept dunnage of uncertain or uncertificated origin.

Disposal of cargo residues: On a bulk carrier, cargo residues become available for disposal in two forms, as solid residues and as washings. Solid residues are spilt on deck or are brought on deck as part of the hold cleaning process. From the deck they can be lifted ashore in drums or skips or they can be put or washed overboard.

The restrictions on putting garbage overboard have been noted above. For example, no garbage except food waste, and no solid cargo residues should be put overboard in the Baltic or the North Sea. For a cargo of 6,000 tonnes, say, the solid cargo residues would probably amount to no more than one tonne, on average.

Cargo residues are also discharged in hold washing water. Such residues, mostly in the form of small particles, pellets, grains or chips, might consist of 3 tonnes of cargo mixed with 500 tonnes of washing water, from a cargo of 6,000 tonnes. The residues of some cargoes such as coke will float, so should be discharged more than 25 miles from land. Other cargoes such as iron ore will sink and should be discharged more than 12 miles from land. Grain residues are food wastes, to be discharged more than 3 miles from land. None of these residues, except the food wastes, should be put overboard in the Special Areas such as the Baltic and North Sea.

Marpol Annex V was first introduced on 31 December 1988 and it is unlikely that, in 1993, these restrictions on the discharge of cargo residues are widely observed. There is no established procedure or routine for discharging bulk residues and many bulk loading berths have no facilities for lifting drums or skips ashore.

It may also be argued that cargo residues are not mentioned in Marpol Annex V, and that there is no authority for including cargo residues in the *Guidelines for the Implementation of the Annex.* The International Chamber of Shipping (ICS) appears to hold this view, since they state[196] that masters should 'avoid the discharge of cargo residues and other materials, including dunnage, not covered by the Marpol Convention without due consideration of the potential effect of such discharge on the local environment'.

As concern for the environment increases it is likely that the requirement will be made clearer and enforcement will become stricter. Disposal of cargo residues is a problem which will not disappear.

The discharge of cargo residues within port limits is a matter for the port or national authority, and there is likely to be considerable variation between the rules for different ports and their enforcement. As a general rule, however, it can be stated that ports are becoming more active in preventing the discharge of cargo residues and associated wastes within port limits[153]. At some modern bulk handling terminals it has been necessary to install elaborate water treatment plants on the quayside and in the stockyard to treat the water used for dust control and for washing the quay before it is discharged from the terminal[201]. Clearly, similar standards will be applied to the ships which visit the terminals.

Disposal of other wastes: There are as yet no Marpol or other international regulations which restrict air pollution beyond port limits. Restrictions within ports are often strict, and strictly enforced. There are no restrictions on the discharge of ballast water in international waters, though the restrictions imposed by several national authorities are noted in Chapter 7.

Sources

93. *Marpol 73/78.* International Maritime Organization. Consolidated Edition, 1991.

153. Baldwin, Captain K. G., MNI. 'Hold Washing & Pollution' *Seaways.* July 1992.

196. *Shipping & the Environment-a Code of Practice.* International Chamber of Shipping. 1993.

201. Rans, Philip. 'UK coal imports and terminal investment'. *Bulktrans '93.* CS Publications Ltd.

CHAPTER 26

BULK CARRIER CASUALTIES

Introduction, bulker casualties and their principal causes, other causes of damage which might lead to loss of a bulker, prevention of casualties, detection of damage, other constructive proposals, summary

THE LOSS of any bulk carrier is a matter of great interest and concern to the seamen who serve in that class of ship. They need to know the lessons which have been learnt from all the bulker casualties which have occurred in recent years in the hope that they can profit from the mistakes which have been made in the past.

The major classification societies, with their extensive records, troops of surveyors and considerable resources, appear to be better placed than any other body to analyse the data and identify the causes of bulk carrier losses. For that reason their findings and recommendations[150] have been given prominence in this chapter. Their advice on the detection of damage is detailed but that on damage prevention is brief and can be summarised as: load and ballast the vessel in accordance with her approved loading booklet, minimise opportunities for corrosion and beware of cargoes which are corrosive or may liquefy. The Nautical Institute's recommendations for putting this advice into effect are presented in full detail later in the chapter.

Besides the classification societies, many other parties approaching the problem from different standpoints have recently taken an interest in bulk carrier casualties. Their theories and advice are also reported in this chapter and are well worth studying. Many bulk carriers have been lost without trace. No-one knows all the answers, and prudent seafarers will take note of all the ways that their ships could be damaged and of any measures that will make them safer ships in which to serve.

It is not the purpose of this book to attempt to apportion blame for the loss of bulk carriers. The way forward is to recognise all the dangers and to adopt prudent practices: for this purpose the various theories have been reported as objectively as possible.

Bulker casualties and their principal causes

Every year since 1971 several bulk carriers have been lost, posted missing in circumstances which in many cases remain unknown. The loss of the ships and the lives of their crew members caused little comment or apparent concern in shipping circles or amongst the wider public over the years. The frequency of these occurrences went largely unnoticed, despite the concern expressed during the 1980s by past and present seafarers such as Douglas Foy[92,98-142] and Captains Boyle[154] and Richardson[97]. The ships were registered under many different flags, their crews came from numerous different countries and they were classed with a variety of classification societies, so the scale of the losses was not readily apparent. Few people noticed or realised that year by year three or four, or occasionally even eight or nine, bulk carriers were lost, as can be seen from the table of bulker casualties at Appendix 26.1.

The years 1990 and 1991 were exceptional for the number of bulk carriers which disappeared at sea or limped into port with structural damage. By the end of 1990 more than 200 seafarers' lives had been lost that year and in November Lloyd's Register, the classification society with the greatest number of ships on its register, announced that it had commenced a review of the published data and a major research project to determine the causes and remedies. The study was limited to ships of more than 20,000 tonnes deadweight as the statistics appeared to show that these were the bulkers most likely to suffer unexplained losses.

Within two months Lloyd's Register announced certain tentative inferences[141] based on their study of the casualties about which they had information. These tentative conclusions have been largely confirmed by subsequent research[118] and can be summarised as follows:

- The great majority of the ships that became casualties were more than 15 years old.
- Many of the casualties which reached port had lost side shell plating.
- A number of the casualties had carried coal followed by iron ore.
- Iron ore had mainly been carried in alternate holds.
- The ships could have been damaged by the methods used in discharge.
- The rates of corrosion of the lower side framing and its connection to the hopper side plating appear to have been high.
- Rates of corrosion appear to have accelerated with the age of the ship and/or to be associated with the carriage of coal with a high sulphur content.
- Inadvertent overloading of compartments can occur.

A further report published by LACS[150] a year or so later added several more items to the list of conclusions about bulker losses.

- The rates of corrosion of vertically corrugated transverse bulkhead plating appear to have been high in some casualties.
- Fatigue cracking at the boundaries of the bulkheads and at the toes of the frame brackets had often occurred.
- It is possible that some cargoes had liquefied, either as a result of high initial moisture content or of flooding.
- Details of design at main frame bracket toes and the termination of topside tank platings at the forward and aft ends of the cargo region may have contributed to structural failure and ship loss.
- There had been a lack of awareness that seemingly minor damage to the side shell structure could spread and lead to flooding of the holds through the side shell plating.

- The higher side shell and transverse bulkhead structures are difficult to reach for close-up inspections. From a distance they may appear in deceptively good condition when actually highly corroded.
- Extreme weather conditions may contribute to the loss of a ship.

As a result of this research it is now widely accepted that a number of bulk carrier casualties were the result of flooding through shell plating weakened by excessive corrosion from coal cargoes and/or grab damage, and highly stressed by the jump (i.e., alternate hatch) loading of an iron ore cargo, possibly associated with inadvertent overloading. Flooding through hatchway damage is also mentioned as a possible first event[107,150].

It is worthy of note that there has, apparently, been little evidence to suggest that losses have occurred as a result of excessive longitudinal stresses. David Robinson of Lloyd's Register, writing in October 1991[180], states 'There is overwhelming evidence that the vast majority of structural failures affecting the seaworthiness of bulk carriers have little to do with longitudinal stresses'. He points out that most failures are fairly evenly distributed along the cargo hold length and originate close to the bending neutral axis. In other words, the damage is not found in the upper deck or double bottom, where longitudinal stress would be expected to show itself.

Ships which are more than 15 years old are considered to be most at risk. The flooding of a single hold would not in itself usually be sufficient to sink a loaded Cape-sized or Panamax bulker with seven or nine holds, so it must be assumed that when ships foundered the flooding had spread to several holds, either by way of watertight bulkheads weakened by corrosion and damaged by the sloshing of flood water or because the shell plating became damaged in more than one hold.

This might be followed by the breaking up of the ship due to the exceptional loads imposed when holds are flooded, particularly if the ship has been weakened by loss of side shell plating. The flooding of No. 1 hold when the vessel is jump loaded is likely in most cases to impose the greatest shear force and/or bending moment on the hull girder and is therefore an even greater hazard than the flooding of a midship hold.[107]

Alternatively, cargo might liquefy and shift in a flooded hold causing a list and resulting in more cargo shifting in other holds, followed by capsize.

Age of ship: Ships are progressively weakened by corrosion and metal fatigue as they become older and it is not surprising that most casualties are older ships. Judgements vary as to the age at which ships become a significantly higher risk, but 15 years is widely quoted[136]. It should be noted that the procedures agreed by IACS for enhanced surveys[151] for bulk carriers require a more extensive survey for all bulkers over ten years old. IMO, indeed, recommends that more rigorous inspections be introduced from the time of the intermediate survey following the first special survey, effectively when the ship is seven years old[158]. A ship which has been cared for, well maintained and safely operated can be expected to trade safely for years longer than one which has been mismanaged and neglected. The trading history is likely to be important, too, and it is significant that sister ships are sometimes found to have very different amounts of damage, suggesting that such damage is not inevitable[134].

Loss of side shell plating: A number of the bulk carrier casualties which survived are known to have suffered serious damage to their side shell plating[123]. In several reported cases large areas of side shell plating became detached, leaving gaping holes in the ships' sides, whilst in other instances the plating fractured and leaked. The damage occurred because the ship's shell plating and associated framing had become weakened by corrosion and stevedores' damage in the areas between the upper and lower hopper tanks, and these weaknesses had not been found and corrected.

Carriage of coal followed by iron ore: Coal and iron ore, with grain, are the three main commodities which enter world seaborne trade so the carriage of coal followed by iron ore is common, particularly in Cape-sized and Panamax vessels. It is now recognised that both commodities have or may have properties which can damage bulk carriers. High sulphur coal when wet produces highly corrosive sulphuric acid[57] which can cause rapid corrosion of the ship's steelwork, particularly on older ships where the hold coatings have deteriorated and offer little protection to the steelwork. Iron ore is a high-density cargo and stress levels reach the highest values that a vessel normally experiences when she carries a cargo of iron ore, jump loaded in alternate holds.

Iron ore mainly carried in alternate holds: Most conventional bulk carriers of handy-size and upwards are strengthened to carry heavy cargoes with alternate holds empty. (The advantages and disadvantages of jump loading are discussed in Chapter 19.) The use of jump loading for the carriage of iron ore cargoes has in the past been almost universal when ships are suitably strengthened.

There are some exceptions, however, such as Australian bulk cargo operators BHP[37] who insist that iron ore fines must be carried in all holds to lower the height of cargo in the hold and thereby reduce danger to the trimmers who can be injured by residues falling from bulkheads during discharge. In addition, resistance by shipmasters and shipowners to jump loading has increased since the link with bulker casualties has been recognised. The owners of two Cape-sized bulk carriers are known to have instructed their masters that iron ore should whenever possible be loaded in all holds. A number of individual ship masters[146,147,148] serving in a variety of fleets have individually taken the same decision.

Ship damaged by stevedores during discharge: Ships can be and frequently are damaged during the discharging process. Damage occurs when the discharging grab or the bulldozer makes heavy contact with the ship's structure. Damage can also be done by hydraulic hammers or grabs used to free residues from the sides of holds. If the damage is incorrectly repaired or the quality of the workmanship is poor, the damage may be made even worse. For example, the correct materials may not be used for the repair of high-tensile steel. A ship which is damaged and badly repaired or which remains unrepaired is at greater risk than is an undamaged ship.

High and increasing rates of corrosion[95, 176, 185] of the side structure[100] and athwartships corrugated bulkheads[150]: High-sulphur coal is corrosive and this is particularly so when it is wet and warm. When the coal is loaded wet, or when sweating occurs because the coal is warm and the sea water on the other side of the shell plating is cold, corrosion is encouraged. In these circumstances the corrosion can be highly localised, affecting those portions of the frames and lower bracket connections that lie closest to the ship's sides.

Athwartships bulkheads which form the boundaries of ballast holds are particularly exposed to corrosion from the damp and salty atmosphere. In addition, all bulkheads (like the ship's side structure) suffer from corrosion caused by problem cargoes. This problem occurs particularly when hold coatings have broken down leaving the steelwork unprotected, a situation found mainly in older ships. Other commodities-such as sulphur and salt, for example-may have a corrosive effect even greater than that of high sulphur coal.

Ship damaged by unintentional overloading of particular holds[150,183]. There are a number of ways, some of them not widely known amongst ships' officers, in which particular holds or blocks of holds can be overloaded. Local overloading of this sort may cause cracking and buckling of structure in both the double bottom and deck areas. An example quoted to illustrate this is cracking of the deck plating at the hatch corners and deformation and/or buckling of plating between the hatchways.

Local overloading can occur when bulk carriers are loaded in ways not foreseen by their classification society or shown in their loading manual[144]. For many years, mariners have assumed that they can adopt any loading distribution unless the loading manual says plainly that they cannot. Unfortunately, the classification societies work on a different basis. They consider that no loading has been approved unless it is shown in the loading manual as having been approved. This has led to misunderstandings and to the adoption by seafarers of unsafe cargo distributions.

A faulty distribution of weights can occur when:

- A ship jump loads to her tropical marks and carries less than full bunkers. In that situation some or all of the strengthened holds may carry a greater tonnage of cargo than they were designed to carry.
- Particular holds are loaded with greater tonnage than the tonnage for which the hold was designed. In older ships the design tonnage for each hold is seldom stated and the loading instrument does not warn when local overloading is programmed[107].
- The vessel is block loaded'"[2].

Block loading, fully discussed in Appendix 9.4, is the name given to a loading in which the ore holds are loaded and one or more of the alternate holds are also loaded. The effect is that two or more adjoining holds are heavily loaded with the adjacent holds empty. The longitudinal strength with such a loading is usually satisfactory and this may lead masters to think that the loading is acceptable, but the problem is actually one of local strength. It has been reported[159] that a number of large bulk carriers have in the past experienced structural damage affecting the cross-deck structure which separates adjacent cargo hatchways at the upper deck level. The single common feature present in all cases was the existence of block loading of cargo holds. Block loading is likely to be considered when the ship is required to load several parcels of ore, possibly in different loading ports or for different destinations.

Fatigue cracking at the boundaries of bulkheads and at the toes of frame brackets: Since surveyors have started making close-up inspections of these areas fatigue cracking has often been found in the bracket toes at the connection of the main frames to the hopper and topside tanks and in the boundaries of the vertically corrugated transverse bulkheads with the upper stools, lower stools and topside tanks. These areas are identified in Fig. 26.2 by reference Nos. (1) and (2). Fatigue cracking is often found in areas which are badly corroded.

Poor design detail: This is a matter for naval architects to resolve, and it is to be expected that class surveyors will look closely at the poorly designed areas of bulkers whilst such ships remain in service. Owners and masters should be informed when weaknesses have been identified, so that they, too, can monitor the condition of the structure in these areas with particular care. The *Executive Hull Summary* or *Planning Document* required as part of the enhanced survey procedure (described later) should help to fill this need.

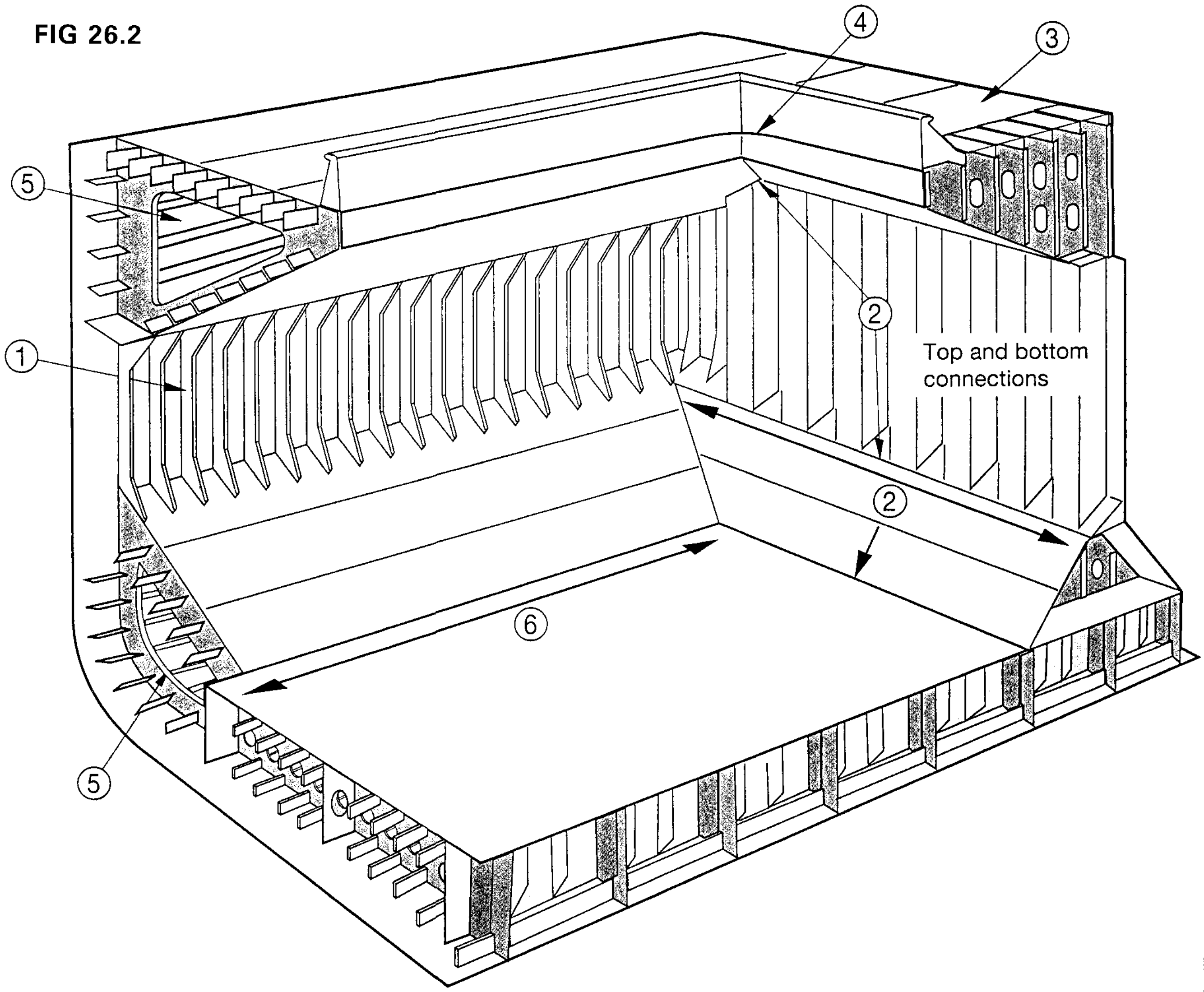
Neglect of minor damage to the side shell structure: Seemingly minor damage to the side shell structure, usually caused by stevedores' discharging operations or by berthing contact, can become more severe (perhaps as a consequence of the ship working in a seaway) and result in flooding of the hold.

Difficulty hi making close-up inspections: The difficulty of making close-up inspections of the higher shell and transverse bulkhead structures is now well known. Very often the need for such inspections was not apparent because from a distance the structure could appear to be in a deceptively good condition, whilst actually highly corroded[150].

Extreme weather conditions: It has been reported[127] that 70 per cent bulker losses occurring between 1980 and 1991 occurred in heavy weather, though no definition of 'heavy weather' is given. Ships should be built and maintained in a condition to survive heavy weather and should do so provided that they are not handled incompetently. A weakened ship will be at greater risk if she meets extreme weather conditions, but such conditions must be expected.

Some cargoes may have liquefied as a result of high initial moisture content or of flooding: If the cargo in a hold liquefies and shifts it will cause the ship to list; if it shifts violently it can cause a severe impact load on the ship's structure. Sliding and liquefaction of cargoes are two processes which have features in common.

FIG 26.2



Problems areas to be given particular attention during inspections

1. Hold frame - connection to upper and lower wing tanks and side shell.
2. Boundaries of transverse bulkheads and bulkhead stools.
3. Cross deck structure.
4. Hatch corners/hatch coaming brackets.
5. Localised cracking and buckling of web frames and breakdown of coatings in water ballast tanks.
6. Inner bottom plating/hopper plating intersection.

Courtesy International Association of Classification Societies

Other causes of damage which might lead to a loss of a bulker

When a ship is lost without trace, as a number of bulk carriers have been, it is not possible to be certain how the ship was lost. When the loss occurs without any distress message, it is reasonable to conclude that the loss must have been very sudden, which suggests the possibility of the ship breaking in two or capsizing. Final foundering, with holds flooded, can also be rapid and will be unexpected if the flooding has not been detected because of darkness and adverse weather.

Even if the problems identified by Lloyd's Register and the other members of IACS account for most of the bulk carrier losses which have occurred, the possibility remains that some ships have been sufficiently damaged in other ways to cause their loss and many possible causes of damage and loss have been suggested. Some theories undoubtedly have a sound scientific basis, whilst others probably do not. Theories from a number of sources are reported below, for information, but with no guarantee as to their validity.

Ship badly operated by inexperienced or incompetent crew[33, 120, 121, 126, 128, 132]: Many commentators have suggested that the problems of bulk carriers are increased by officers and crews who are inexperienced and/or incompetent. There is no doubt that a failure to follow safe loading and discharging routines can damage a ship.

Twisting the ship[37, 144, 156]: If a ship is loaded with extra weight to starboard of the centreline in one hold, and to port of the centreline in another, stresses which tend to twist the ship will be created. This problem is known to naval architects as cargo torque and can easily occur if the ship is loaded using two loaders which do not both plumb the centreline. It can also occur with a single loader if the deballasting of double-bottom tanks is done unevenly and cargo is used to correct the list introduced by uneven ballast distribution.

Twisting the ship can also occur during ballast changes if diagonally opposite tanks are emptied to reduce longitudinal stresses. Whilst reducing one set of stresses a second set are introduced/ Uneven transverse distribution of cargo and ballast, if of large magnitude, can result in damage to the cargo hatchway corners and cross-deck structure whilst working cargo or in a seaway.

Ship damaged by berthing impact: Ships can be damaged by landing heavily on the quay or on the fenders during berthing. This is primarily a problem for vessels berthing without the assistance of tugs. Ships can also be damaged by contact with fenders or wall when passing through locks, by violent contact with a tug, or by contact with ice. Like stevedore damage, contact damage can be made worse by a faulty repair and a ship which is damaged and badly repaired (or which remains unrepaired) is at greater risk than is an undamaged ship.

Classification society rules for wave loadings: Correspondence[164, 165, m] in *Lloyd's List* has quoted Professor Seeding, a leading wave load expert, to the effect that when deciding upon the proper design and scantlings of side shell structure 'the rules of most of the classification societies are totally unreasonable' with reference to the wave load assumed to be acting on the ship's side shell. The main criticisms put forward by the correspondents are that different societies make very different assumptions which are difficult to compare, and that the values assumed in most cases are unrealistically low.

If the values used are indeed unrealistically low this would make the structure weaker than is necessary to withstand the swell conditions met at sea. The classification societies state, however, that this criticism fails to take account of the full extent of their calculations, and that known failures are not consistent with this theory.

Water pressure against unsupported side shell plating[134, 136]: When a vessel is jump loaded with iron ore some holds are empty and the remainder contain iron ore which is usually untrimmed and piled in the centre of the hold, making little or no contact with the ship's sides (Fig. 1.5). Since there is no cargo resting against the side shell plating, supporting it against the pressure of sea water on the outside, this plating can flex more, increasing the risk of cracking and failure. This problem can be reduced by trimming the cargo reasonably level to the boundaries of the space. However this has a variety of consequences.

Sliding solid bulk cargoes[138]**:** Solid bulk cargoes can shift by sliding or liquefying. Whilst the consequences-listing or capsize, and structural damage-may be the same, the two processes are different.

Sliding occurs when the cohesive strength of the cargo, its 'stickiness', is insufficient to withstand the effects of rolling. Unfortunately cohesive strength is a property which varies according to moisture content and the height of the stockpile as well as other factors. In addition, the moisture content of a cargo can vary during the voyage-for example, if a cargo drains the surface may dry out and the bottom become wet, leaving both top and bottom with no cohesive strength. The accurate measurement of the cohesive strength of a cargo requires expertise, is a time-consuming process and the result is of limited value since it may change during the voyage.

A good illustration of how cohesive strength varies is provided by sand which, when damp, can be used to make sandcastles with heights of up to about 30 cm. Dry or very wet sand has no cohesion and cannot be used for sandcastles: any steep slope will collapse. Even when the sand is damp the cohesive strength does not allow the building of structures which are more than about 30 cm in height.

The angle of repose of a cargo (the slope which it assumes when poured) was previously used to decide which cargoes needed to be trimmed. This measurement is now considered to be unsatisfactory, since it ignores the cohesive strength of the cargo.

It is not practical routinely to make all the tests and calculations necessary to confirm that a particular cargo will not slide, so the IMO Sub-committee on Containers and Cargoes now recommends[138] that all solid bulk cargoes be trimmed reasonably level unless there are very sound reasons for doing otherwise. Trimming a cargo reasonably level does not guarantee that it will not slide, but it goes a long way in that direction. 'Reasonably level' is meant to convey that the surface can be like a ploughed field and need not be like a billiard table. Trimming only within the area of the hatch square is better than no trimming, but the side slopes remain a hazard.

Liquefying of solid bulk cargoes[22,145,170]: Certain buk commodities generally those with a small particle size, are liable to liquefy if they contain too much water. Cargoes most at risk are those which contain water as a result of the way they are processed before loading, iron ore concentrates being an example of this. Even though they may appear to be in a relatively dry granular state when loaded, such cargoes may contain sufficient moisture to become fluid when compacted and subjected to vibration during a voyage.

When fluid the cargo can flow to one side of the ship, causing a dangerous heel and capsize. One authoritative paper[157], reporting research done in conjunction with Lloyd's Register, states: 'Cargo can shift due to it sliding on a saturated base layer caused by the downward migration of its water content, without liquefaction occurring. The effect of this on ship stability could be serious, but if liquefaction also occurred and a virtual landslide was let loose in the holds, the effect on ship stability could be catastrophic. In addition to the safety hazard presented by reduction in stability, a virtual landslide of cargo could impose a severe impact load on the ship structure, when brought to rest from its sudden and rapid movement'.

This danger should be avoided by obtaining details of the moisture content of the cargo and ensuring that it is less than the transportable moisture limit. If there is any reason to suspect the reliability of the details provided, the moisture content must be rechecked using the procedures given in the *BC Code*[2,2]. All cargoes which are liable to liquefy should be trimmed reasonably level to the boundaries of the cargo space. A cargo which is well trimmed is less likely to shift.

Failure to trim cargo reasonably level: The IMO recommendations for the trimming of bulk cargoes have become more exacting with the passage of years and the 1991 edition of the *BC Code* recommends that all bulk cargoes should be trimmed reasonably level to the boundaries of the cargo space, except when the history of past shipments shows that, because of the properties of the material, a lesser degree of trimming is safe. In 1993 it is still normal practice for iron ore cargoes not to be trimmed[163].

There are five alternative methods of trimming bulk cargoes Ievel[177]-namely, by free pour, by integral spout machine trimmer, by deflectors, by separate machine trimmers, and by hand trimming. The cargo within the hatch square can be trimmed reasonably level by free pouring successively in every part of the hatch square, building a series of small peaks all to the same height. Spout trimming, with a trimming shoe or rotating head on the end of the spout, is used for coal and grain and can be used for ore and concentrates. Separate deflectors can be used, like the spout, to direct cargo into the corners of the hold. The fourth available method of trimming is to use a machine trimmer-for example, a bulldozer lowered into the hold on top of the cargo to trim the cargo out to the ship's side. This process compacts the cargo, which may make it more difficult to grab out at the time of discharge[62]. Hand trimming with shovels is unsuitable for closeweight cargoes, except for small parcels.

When a cargo is not trimmed, but is poured amidships and forms a cone in the centre of the hold, there are benefits. The ship remains upright throughout the loading. On most ships this helps with the deballasting, except whilst stripping. The danger of twisting the ship during loading is reduced. If trimming is not required no trimming equipment is needed. The ship will suffer no delay caused by trimming. The cargo is well placed for the normal grab discharge and is not compacted. Since little of it comes in contact with the sides of the ship, more of it can be grabbed directly and there is less need for bulldozers and trimmers at the time of discharge to remove the cargo from the ship's sides. Stevedores' grab damage ought to be less, since there is less need for the grab to work close to the ship's sides. Cleaning should be less, since less cargo comes into contact with the ship's structure.

To summarise, if the cargo is not trimmed there are savings in equipment needed and the capital cost thereof, in time spent loading and discharging, and in the work which has to be done. These benefits must be weighed against the risk associated with a failure to trim.

When the cargo is trimmed reasonably level to the boundaries of the cargo space, as recommended in the *BC Code,* it is less likely to shift as a result of sliding or liquefying. That makes it less likely that the ship will develop a heavy list, or even capsize. An additional benefit is that the weight has been winged out-i.e., moved into the wings (or sides) of the hold-and this reduces the speed of the ship's roll, making the motion less violent and uncomfortable. The cargo also provides support against water pressure for the ship's side shell plating.

Faults in construction of vessel[160]: A ship which has been badly constructed, with defects built into her, is at greater risk of becoming a casualty. An allegation often made about the *Derbyshire,* the British OBO lost in the Pacific in 1980, and her sister ships is that they had a structural fault around frame 65.

Use of grade 'A' steel (which has no guaranteed fracture toughness) to build bulkers: It has been stated[140,1r,2] that grade 'A' steel has no proven fracture toughness and that substantial quantities of it are still used in the construction of bulk carriers, although its use is being reduced. It is said to be an unnecessary risk to have ships which have large or multiple fatigue cracks, but which have no proven fracture toughness in the material at the crack tip.

Corrosion in topside tanks[134]: The topside tanks are continuously subject to a salty atmosphere and it is well known that they are particularly prone to corrosion, which reduces the thickness of plating and thereby reducing the longitudinal strength of the ship. The topside tanks, which are formed by the deck, topside shell plating and sloping internal bulkhead of the tanks, are the only parts of the ship's structure which resist longitudinal compressive bending loads whilst the vessel is in sagging condition. If this part of the ship's structure fails the ship will fold up and probably sink.

Damage to double bottoms[134]: The double-bottom structure is built very strongly to allow for the heavy loads to which it is subjected. These include the effects of water pressure acting upwards and the downward pressure of the cargo. This latter has its greatest local effect when the ship is jump loaded with a closeweight cargo, the cargo is peaked in the hold, and the hold is overloaded, as can happen in practice[135]. The effect of loading alternate holds is to induce large bending shear stresses in the double bottom, stresses for which allowance is made in the design. Double bottoms can be damaged by the impact of heavy grabs[100] which nowadays commonly have an unloaded weight of 35 tonnes, by the tipping of heavy items of cargo such as pig iron or scrap metal into the holds from a height[179], and by corrosion within the double-bottom ballast tanks. It is also suggested[152] that the dropping of iron ore on to the tanktop from height of more than 27 metres may do harm on impact. Corrosion of and damage to the double bottom could lead to collapse, resulting in failure of the hull girder and the ship breaking in two.

Flooding through dump valves[33]: A considerable number of bulk carriers are fitted with dump valves (drop valves, or screw-down overboard drain valves) which allow them to discharge the ballast held in topside tanks by gravity through an opening at about the level of the load waterline.

Serving seafarers have reported that on loaded passages during heavy weather, water has entered the lower ballast tanks through these openings and the ducting which, on some ships, connects the topside and lower hopper tanks. Such flooding, due to leaking valves or the failure to close them properly or at all, would be slow and in heavy weather hardly noticeable. It will remain undetected if soundings are not taken because of heavy weather or for any other reason.

The amount of water which can enter can be thousands of tonnes over the course of some days, with the rate increasing as the ship sinks deeper. While the loss of buoyancy and freeboard may be insufficient to cause a casualty the resultant increase in stress, from local overloading, could be catastrophic.

Failure of hatch covers[134]: In a laden bulker with a low freeboard, no raised forecastle and virtually no foredeck, the forward hatch is likely to be more or less permanently awash in heavy weather. Total failure of hatch covers, it has been claimed on the basis of plastic analysis, can occur in a new ship with about 4.0 metres of water over the hatch. If the hatches have been corroded, failure will occur with a smaller depth of water. Damage to covers can also be sustained by overloading when carrying deck cargoes, and by over pressure or under pressure of the ballast holds when used to carry water ballast.

A forward hold loaded with iron ore would contain plenty of empty space, so a very large amount of water could enter. This would trim the bow down, allow green seas to roll up the main deck and place all the hatch covers at risk. During rough weather this could happen at night on a large bulk carrier without anyone on board realising what had happened. The additional trim due to flooding of the forward hold would only be about 1° on a large vessel, almost imperceptible in a heavy swell with the vessel pitching. Once the second and possibly third holds had flooded, the vessel would nosedive and sink very rapidly.

Hatch cover fastenings sprung open by flexing of the ship: It has been suggested that hatch cover fastenings could be sprung open by the flexing of a bulk carrier in rough weather. If covers opened in such circumstances it could lead to flooding of a hold and consequent loss of the ship. If such an event were possible, then instances of the fastenings being sprung open without the ship being lost could also be expected, but little has been published to support this theory.

Failure of hatch cover fastenings due to inadequate maintenance, or faulty operation: This is a fault which most certainly can occur in some systems of hatch cover as a result of loss of pressure in the hatch hydraulic system coupled with poor adjustment of the hydrocleats and lack of renewal of cleat washers. This could lead to flooding of a hold and consequent loss of the ship. The ill-fated *Marina diEqua,* a handy-sized bulker which was photographed in the Bay of Biscay shortly before she sank in 1981, appeared to have her No. 1 hatch covers partly open and to be heavily down by the head. Her loss could have been due to hatch covers sprung open by flexing or to inadequate maintenance or faulty operation.

Failure of transverse watertight bulkheads[134]: The transverse watertight bulkheads which separate a bulk carrier's holds can be damaged by cargo operations, by corrosion and, in the case of the ballast holds, by the sloshing of ballast water. The failure of such a bulkhead would not lead directly to the loss of a bulk carrier carrying a dry bulk cargo, but it might allow sufficient flexing of the side shell, bottom and/or deck to induce cracking and loss of watertight integrity.

Once a hold is accidentally flooded for this or any other reason the danger of progressive collapse of bulkheads becomes much greater. The flood water, which may have its density increased by cargo in suspension, can exert on the bulkhead a pressure which is much greater than its design load, a problem made worse by sloshing of the liquid. If the source of the flooding is the sea it is likely that several bulkheads will fail progressively, allowing a large amount of cargo space to flood and threatening the loss of the ship.

Failure of structure in ballast compartments due to sloshing[156-166]: Ballast water sloshing in a part-filled ballast tank or ballast hold can damage the ship's structure, and naval architects advise that it should not be allowed to happen or that any occurrences should be kept as brief as possible whilst the tank is filling or emptying. The maximum damage is likely to occur in rough weather when the compartment is about half full, and some classification societies advise that ballast holds should not be left filled to 25 per cent-75 per cent of capacity. The documents issued to many older ships contain no such warnings and it is likely that some older ships have suffered weakening of their structures from ballast water sloshing in part filled ballast compartments.

High loading rates: Loading rates of up to 16,000 tonnes/hour, achieved by using two loaders, have been quoted for the iron ore ports of Punta Madera and Tubarao and recently (1993) for the coal port of

Richards Bay. Many people in the shipping community have suggested that these rates may in themselves damage bulk carriers[136], but this suggestion has been described[134] as unrealistic because the rate of loading required to induce dynamic hull flexing is of the order of 1,000 tonnes/second, and the ports with the highest loading rates do not have the worst casualty records[122]. High loading rates do, however, create other problems such as the inability to keep to the loading/deballasting programme.

Fatigue cracking of the steel structure[134]: Fatigue cracking occurs at points such as hatch corners where stresses are locally high. Such cracking is the result of cumulative damage caused by cyclic loading of the structure and invariably starts at the welded joints. The fatigue life is the time required in service for the structure to experience enough stress cycles for a crack to occur, and a bulker is designed so that with proper maintenance cracking should not occur until a fatigue life in the region of 20 years of operation has been used up.

Fatigue life, once used up, cannot be regained except by complete replacement of the welded joint, so life extension programmes carried out on bulkers do not extend the fatigue lives of welded joints that have not been replaced.

The consequences of fatigue cracking can range from a completely benign crack which relieves a stress concentration without overloading or endangering any other detail, to side shell cracks which allow water ingress. It is even possible for a crack to start a major brittle fracture at low temperature which could break the hull in two, though the quality of special grade modern steel, welding techniques and detailed designs make such brittle failures extremely rate, though not impossible.

Consequences of using high-tensile steel[131,134]: High-tensile steel (HTS) has been increasingly used in the construction of bulk carriers because it greatly reduces building costs by reducing the manhours required for welding. It also allows the handling of larger prefabricated units without increase in weight. HTS has a significant weight advantage when compared with mild steel of the same strength. The reduction in hull weight has the additional benefit of allowing a ship of a given size to carry additional cargo.

However, the use of HTS incurs penalties. HTS structures are subject to higher levels of stress than those of mild steel because they are thinner and hence more flexible. In addition, because HTS is thinner, each millimetre lost by corrosion is a greater percentage loss and corrosion is also likely to be faster because HTS is more flexible. Since the fatigue properties of HTS are similar to those of mild steel, the higher level of stress to which HTS structures are subject shortens the fatigue life of components of standard design HTS.

Failure of ship designers to take account of the fact that ships are flexible structures[143]: Those who support this theory say that ships are flexible structures which are subjected, whilst in service, to steady and also irregular loads, distortions and stresses. The hydroelasticity theory has been developed to predict the effects of these varying loads and stresses.

When the still water and dynamic stress variations along the hull are predicted using the hydroelasticity theory, the results show that dynamic loads and stresses induced can be several times larger than the corresponding still water loads, and that large stresses may occur away from midships and, in particular, towards the end of the hull. This is noteworthy because a number of reported casualties to bulkers and tankers have involved the ship breaking in two in way of the collision bulkhead or in the vicinity of the bridge front. This theory remains controversial and its basis and conclusions are not accepted by many traditional naval architects.

Areas particularly prone to cracking[107]: The fore and aft end transition zones-i.e., the side shell areas in the forward part of No. 1 hold and the after part of the aftermost hold-are particularly prone to cracking. Several factors contribute to this:

- Discontinuities between longitudinal hold structures and the structures in the foreship and in the aftship.
- The shape of the hull cross-sections forward and aft causes increased slenderness and flexibility of side structure near the more rigid end structures.
- Complete prefabricated portions of the ship are often joined (hand welded) close to the collision bulkhead and the engineroom bulkhead.
- Because of the finer shape of the hull cross-sections in these regions the hopper side tanks are closer to the hatch square and thus more exposed to rough loading and discharging procedures.

Wave-excited hull vibration[133]: Hull vibration which occurs when a ship meets waves comes in two forms. Springing is the name given by naval architects to continuous vibration caused by wave action, whilst slamming and pounding are names for the transient or short-term vibration which occurs when a ship meets waves during heavy weather.

Ships are more likely to suffer from springing, which is a form of heavy vibration otherwise known as flexing or whipping, when the hull possesses low damping properties as is the case when high-tensile steel has been used in their construction. Springing in low sea states is reported to be common for ships over 200 metres in length.

Any form of hull vibration will cause fatigue in the hull, thus reducing the vessel's fatigue life, and it has been suggested that wave-excited hull vibrations could be of considerable importance in relation to structural failures of ships, this applying in particular to bulk carriers on account of the low damping properties which their hulls are reported to possess. (The procedure for preventing springing is described in Chapter 8.)

Unexplained hull flexing: One report[52] tells of excessive and alarming hull flexing which occurred on a Cape-sized bulk carrier on several occasions when she was part loaded with coal, with some holds full and others empty, and on passage between the first and second discharge ports. The observer suggested that this phenomenon may have been caused by stresses locked into the ship's structure by the uneven loads on the shell plating along the length of the ship. Another possibility is that this was an example of wave-excited hull vibration, triggered by the unusual weight distribution.

Ship driven too hard in adverse weather[97, 117]: Aboard a Panamax or Cape-sized bulker the stem of the vessel is likely to be more than 200 metres from the navigating bridge. When a laden ship meets bad weather her blunt bows will *slam* the swell, this being the name given to the violent collision between ship and sea. When in ballast and meeting rough weather the bows rise clear of the water and smash down on the sea surface from above, in a process known as pounding. Both slamming and pounding will damage a ship, but the bows of a larger bulker are so far distant from the bridge that the violence of the slamming or pounding in rough weather is not easily detected. In these circumstances it is easy to fail to notice or to ignore the severity of the conditions the ship is meeting, particularly at night or if there is a deadline to meet.

One sign which warns of adverse conditions is when the ship slows down whilst the engine settings remain unaltered. If the ship is slowed 25 per cent by adverse weather-for example, if she is reduced in speed from 12 knots to 9 knots whilst at constant engine settings-The Nautical Institute recommends that the rpm should be substantially reduced to avoid damage from forcing the ship into the weather.

A few ships have been fitted with equipment (described in Chapter 8) for the monitoring of hull stresses. Such equipment is intended to give warning at any time that the ship's hull is being overstressed, enabling the officer of the watch to adjust course or reduce speed to avoid excessive stress.

Ship damaged by unsuitable distribution of weights: If the weights aboard a ship at any time are badly distributed it is possible for the ship to be subjected to excessive longitudinal bending stresses and shear forces. In these circumstances the stresses, if correctly calculated by those on board, would be found to be excessive and likely to lead to structural damage.

It is the responsibility of the ship's master and officers to make sure that a ship never is overstressed, but there are a number of situations in which they may fail to do so. Such situations are most likely to occur when a ship is loading, discharging or carrying a high-density cargo, such as iron ore or mineral concentrates, but can occur with incompetent loading when the cargo is a commodity such as grain, or when the ship is in ballast[33-120-136,156,166,168,182-183].

Such mistakes can occur in any of the situations listed below, and doubtless there are others:

- When the master and his officers fail to calculate a full, safe loading/deballasting or discharging/ballasting programme. This might happen because: they make errors in their calculations; they fail to realise the importance of the calculation and do not bother to do it; they are unable to make the calculation because the loading instrument is out of order and they cannot do the longhand calculation; the loading manual is written in a language they do not understand; the loading manual contains errors; they overlook warnings which are contained in the loading manual, but which are not prominent; they think that the ship when in ballast is subject only to low stresses, which do not need to be calculated; they are so inexperienced that they are unable to devise a safe loading, or to recognise that the loading they have chosen is unsafe.
- When there is a departure from the loading/deballasting or discharging/ballasting plan. This can happen when: the ballast operations get out of step with the cargo operations; mistakes are made in the quantities delivered; the needs of the terminal change and they fail to inform the ship, or force the change on to an unwilling ship; the needs of the ship change and they fail to inform the terminal and to produce a revised programme; ship's personnel fail to monitor the programme and the terminal staff depart from it.
- When ballast or cargo compartments are accidentally flooded, particularly when the ship is jump loaded.

Explosions aboard combination carriers[117-167]**:** Explosions can occur in combination carriers due to explosive gases in ballast compartments or void spaces. This danger is well documented, but continues to present practical problems for ships' personnel, particularly in the cases of those OBOs which have combined side and double-bottom tanks with a single air pipe at the forward end. Such ballast tanks cannot easily be cleaned or gas freed.

Prevention of casualties

Around 1991 it became obvious to every commentator that there was a safety problem with bulk carriers. Since that time a variety of organisations have taken action aimed at preventing further casualties, or identifying and excluding substandard ships from their ports and operations. Of greatest interest to the ships' officers are the measures that can be taken by ships' officers and shipowners to reduce the risk of their ships becoming casualties. These measures come in two categories: those designed to prevent damage; and those intended to discover damage so that it can be repaired.

Casualty prevention by ships' personnel and shipowners

The prevention of damage to the ship's structure is of considerable importance to the shipowner and of even greater importance to the seafarer who may lose his life if his ship becomes a casualty. Structural damage is not inevitable, as is illustrated by the fact that sister ships are sometimes found to have quite different levels of damage. This is a matter over which conscientious seamen supported by their owners can exercise considerable influence. Prevention of damage by the use of safe procedures and good planning and by firm dealings with shippers, stevedores, trimmers and receivers is work which is worth doing well.

The recommendations which follow have been compiled by The Nautical Institute's Bulk Carrier Working Group, and list ways in which the International Association of Classification Societies' brief recommendations for reducing structural failures can be put into effect.

Where the adoption of any of these recommendations would require a departure from established company policy, The Nautical Institute would expect a shipmaster to consult his employers before adopting the recommendation.

Minimise corrosion within holds by maintaining paint coatings. The areas most liable to suffer from corrosion are the frames and adjoining areas against the ship's sides, and the transverse bulkheads. These areas are less exposed to scouring by cargo or cargo-handling equipment than are tank tops and lower hopper sides, so paint coatings, if properly applied, can last reasonably well. Paint coatings should be maintained. Holds which have been routinely washed with sea water should where possible be given a final rinse with fresh water. Ships which are continuously employed carrying the same corrosive cargo, where holds are not cleaned between cargoes, have a higher risk of corrosion. A procedure of pumping bilges regularly during the voyage will reduce corrosion at tanktop level and within the bilge system, but will not stop corrosion which occurs as a result of sweat. Extra precautions should be taken when the cargoes are corrosive.

Minimise corrosion within ballast tanks by maintaining coatings. The touching up of mechanical damage and local corrosion is suitable work for a ship's crew, but a complete descaling and recoating probably requires shore labour and equipment.

Prevent stevedores' damage by close supervision of the stevedores to prevent bad practices, and by holding them responsible for any damage done.

Prevent hull contact damage by proceeding carefully when berthing, unberthing, manoeuvring and passing through ice.

Report damage, and have it surveyed and properly repaired: Ensure that damage, when found, is reported to owners. All except minor damage should be reported to class and surveyed by a class surveyor. It should be properly repaired by a competent person.

Avoid local overloading: Ensure that maximum persmissible hold tonnages are known, and are not exceeded. Do not exceed maximum tanktop loadings. Avoid block loading. Monitor loading and prevent delivery of excess tonnage to hold. Distribute closeweight cargo evenly over the length of the hold.

Provide accurate, accessible stability information: Ensure that the ship's stability and loading information is readily available, accurate and easy for the officers to use.

Prepare a full loading/deballasting or discharging/ballasting plan: Use The Nautical Institute's form or a similar one and make sure that every stage is within permitted longitudinal bending stress and shear force limits.

Keep strictly to loading/deballasting or discharging/ballasting plan: Accept changes to the plan only when an amended plan has been fully calculated and found to be safe.

Reduce loading rates when starting an empty hold[130, 188]**:** While the cargo is being poured directly on to the tanktop the loading rate should be reduced. Cargoes which can cause damage require special care. The first grabloads of scrap should be lowered close to the tanktop before being released. When pig iron is being loaded the tanktop should be shielded from the first pour by temporary sheathing such as pallets.

Ensure that discharging and ballast changes are planned and executed with the same care as loading: High values of longitudinal bending stresses and shear forces can be reached by unplanned or careless operations. They should be avoided.

Reject cargo with excessively high moisture content: Insist on being provided with a certificate of transportable moisture limit, and follow the guidelines laid down in the *BC Code*[212].

Ensure that,ship is not twisted whilst loading or changing ballast: Twisting can occur if two loaders do not operate exactly in tandem, or if a single loader distributes cargo unevenly between port and starboard sides. This damage can also be caused by uneven changing of ballast.

Close dump valves immediately deballasting is completed: Ensure dump valves are well maintained and do not leak and have a routine to ensure that they are closed when deballasting is completed.

Trim cargo reasonably level to the boundaries of the cargo space: Cargo should be trimmed in accordance with the *BC Code*[212].

Ensure that cargoes such as steel are well secured: Cargo which breaks adrift can damage the ship's structure. Securing should be in accordance with the *IMO Cargo Securing Code*[96].

All hatch covers should be well maintained and carefully secured: The hatch covers must be in sound condition, with a cleating system which is well maintained and correctly operated.

All deck openings should be in sound condition and properly secured: This applies upon sailing, at night, during adverse weather and any time when there is no need for them to be open.

Speed should be substantially reduced in adverse weather: When adverse weather causes a speed reduction of 25 per cent (for example from 12 knots to 9 knots) with constant engine speed, the rpm should be substantially reduced to avoid damage from forcing the ship into the weather.

Avoid continuous heavy rolling: Heavy rolling results in the repetitive heavy loading (panting) of the side shell plating as the pressure of sea water is applied and removed. Ships are built to withstand this treatment, but can be harmed when rolling is excessive and prolonged.

Sloshing of ballast water hi part-filled tanks should not be allowed to occur: As far as possible ballast tanks should be filled or emptied before bad weather is met, this precaution being particularly important in the case of ballast holds and topside ballast tanks, both of which have large open areas which allow sloshing.

Prevent springing by adjustment of course, speed or ballast: Springing, otherwise known as whipping, flexing or wave-excited hull vibration, can be prevented by adjustment of course, speed or ballast. It will disappear with change of loading.

Aboard OBOs follow strict procedures to avoid the possibility of gas explosions: When carrying dry bulk cargoes all compartments, including void spaces, empty ballast tanks and duct keels, must be scrupulously gas freed. Thereafter they must be regularly rechecked for gas to detect any unsuspected gradual build-up.

Additional measures

The following additional measures have been adopted by some shipowners and maritime authorities, and The Nautical Institute list them for consideration by those who want to provide a greater margin of safety than that which the classification societies require.

Stay within the at-sea stress limits whilst in port: To reduce the longitudinal bending stress and shear force during loading, plan the loading to stay within the at-sea stress limits in port.

Increase the number of loading passes: To reduce the longitudinal bending stress and shear force during loading, increase the number of passes used for loading (e.g., make three pours into each hold instead of two).

Insist that a maximum loading rate (e.g., 5,000 tonnes/hr per loader) **is not exceeded.**

Avoid jump (alternate hold) loading of closeweight cargoes, and load all holds.

Casualty prevention by other interested parties

Classification societies: The major classification societies have introduced enhanced surveys[131] of the 'cargo length' of bulk carriers, phased in from 1 July 1993. The new requirements provide for more frequent and more thorough close-up inspections of hold and ballast tank structures, measurement of steel thickness, and monitoring of the condition of coatings. Thoroughness of inspection increases as the ship becomes older, if substantial corrosion is found, and if hold and ballast tank coatings are not well maintained. A copy of the record of thickness measurements is to be retained aboard and will be available along with the hull survey report, for inspection by all interested parties. These documents were previously confidential between classification society and clients.

In new buildings the cargo hold frames and end brackets are to be of a greater minimum thickness to provide an increased reserve against corrosion. In addition, the side shell and side frames and end brackets are to be coated.

A universal IACS database has been established for tracking 'troublesome' tonnage. It is intended to make it more difficult for owners of substandard ships to evade survey or repair requirements by switching register. Classification societies are reported to be refusing class to more vessels than hitherto, and disclassing more vessels because their condition is unacceptable.

Classification societies have been encouraged[152] to continue to press for greater selective use of steels with guaranteed fracture toughness. IACS has introduced an early warning system which accepts reports of hull damage to bulk carriers over 20,000 tonnes from member classification societies and detects trends, allowing early remedial action to be taken.

The classification societies have given publicity to their findings and have also issued advice[105, 107, 116, 137, 15o] to the shipping community about the visible signs of structural damage and how to recognise them.

National administrations: Certain national administrations-for example, Australia, Canada[194] and Norway-have introduced more thorough examinations of bulk carriers visiting their ports. Older bulkers or those flying particular flags have been subjected to careful inspection and detained if considered unsafe or unseaworthy.

Port State control inspections in Europe have been strengthened, with an increasing number of ships being detained for deficiencies, including corrosion that threatens structural integrity. An increasing number of countries are undertaking inspections and there are plans for the introduction of regional schemes in Latin America and the Asia/Pacific region to strengthen the work already being done by some countries in these areas. The Australian and Canadian administrations are reported to be strictly enforcing the loading recommendations of the *EC Code*[2,2].

Underwriters: London underwriters have introduced a structural condition warranty to be written into the hull insurance policies of ships suspected of being substandard. It requires the owner to provide a satisfactory Salvage Association survey certificate. Compliance is expensive since the survey is at the shipowner's expense and can involve loss of hire for several days whilst the survey takes place.

Norwegian underwriters have introduced a hull policy which leaves vessels uninsured if they are not adequately maintained. An increasing number of insurance companies are reported to be demanding full condition surveys. The P&I Clubs have stepped up the number of condition surveys they carry out on ships entered with them or applying for entry.

Shipowners: Several shipping companies have installed hull stress monitoring equipment (described in Chapter 8) aboard some of their bulkers. This equipment measures longitudinal bending and slamming stresses, assisting masters to recognise when high stress levels are being reached and to take action to avoid them.

A number of shipowners require their ships to remain within the at-sea stress limits whilst loading and discharging, as far as possible. With careful planning the number of occasions on which it is necessary to exceed the at-sea limits is small.

The owner of two Cape-sized bulkers recommends a maximum loading rate to 5,000 tonnes/hour per loader. High-density cargoes such as iron ore are normally to be loaded in all hatches. The number of loading pours should be more than the minimum possible to keep stresses at a low level. One shipowner has a professional/qualified steelwork team who are permanently employed afloat, moving from one bulker to another in succession, inspecting and repairing the steelwork.

BHP Transport Ltd are taking part in a research programme to develop new hull condition monitoring technology. Australian shipowners have adopted a *Code of Practice*[195] for safe, efficient and environmentally friendly operation of ships. Its provisions are general, not specific.

Intercargo, the International Association of Dry Cargo Shipowners, has issued recommendations[178] addressed to all those concerned in the trading of bulk carriers, for promoting safety. The organisation has also promoted a scheme for the scrapping of old bulk carriers[119]-[178 186]. The International Chamber of

Shipping has collaborated with other interested parties to produce a ship-shore safety checklist for bulkers[85].

Shippers and loading terminal operators: Experienced marine advisers are being employed by shippers and terminal operators more often than was previously the case. Ships presented for loading are being inspected more often and more thoroughly by surveyors representing shippers. Ships aged more than 15 years are rejected by some shippers, as a general rule, it is reported.

International Maritime Organization: The IMO placed the safely of bulk carriers high on its agenda in autumn 1991 when it recommended that classification societies, shipowners, governments and terminal operators-in fact, all concerned with bulk carrier safety-give close attention to structural integrity of these vessels and the effects upon them of corrosion.

Casualty prevention in general: Whilst the foregoing initiatives may seem very extensive it is not clear, in many cases, how widely, vigorously or persistently they will be applied, particularly when commercial pressures encourage a relaxation of precautions. It would be a great mistake to think (in 1993) that the problem of unseaworthy bulk carriers has been eliminated.

Detection of damage

Inspections: When damage cannot be prevented it must be detected, reported, examined and repaired. The enhanced programmes of surveys introduced by the classification societies should ensure that they find damage earlier than was previously the case, but this may not be good enough. Unexpectedly high rates of corrosion have been reported[57, 102, 176] and it seems that a ship's steelwork can deteriorate rapidly when exposed to corrosive cargoes, excessive loads or mechanical damage. It is therefore highly desirable that ships' personnel should also take an informed interest in the condition of their ships, inspecting carefully for damage and excessive corrosion.

It is unrealistic to imagine that ships' personnel can make a close-up inspection of every hold every voyage, but it should be possible to examine every hold thoroughly about once a year, provided that suitable equipment is available to allow the inspector to make a close-up examination of the full height of the frames. A geared bulker can carry a cherrypicker and place it in the hold when required, but for gearless vessels a system of lightweight aluminium ladders[149] is probably the best option. It is essential that shipowners ensure that ships' personnel have an efficient means of inspecting areas high in the hold.

On occasion it is possible to inspect the higher parts of the hold from the surface of the cargo, and ballast holds when part filled can sometimes be inspected from a raft. However, these possibilities are the exception and cannot be relied upon. The hold must be washed clean for an effective inspection and the hatchcovers must be open to admit daylight. Conditions are likely to be most favourable on a sheltered river or fjord transit or at an anchorage.

It has been argued that such an inspection may only find 40 fractures when there are actually 120 to be found, but that misses the point. Forty fractures are quite enough to alert the master, the owners and the classification society to the fact that the ship's condition has deteriorated and needs urgent expert examination. Ships' officers cannot replace the classification society surveyor, but they can help to make sure that he overlooks nothing which is important.

Practical advice on the conduct of surveys of damaged holds has been offered by a surveyor experienced in this work whose advice[172] can be summarised as follows. The owner will expect the master to advise him of any stevedore damage, and any visible cracking in the ship's structure. Wastage due to corrosion is sometimes difficult to detect. In one actual case high-tensile steel had wasted very evenly, without obvious critical spots, so there was little to show that heavy corrosion had occurred. Masters should be alert to this possibility.

The second area of concern reported by the same surveyor is the problem sometimes found in ships' frames, which suffer a high level of 'grooving' or 'necking' right next to the weld where the frame is attached to the ship's side. When the structure is stressed, the frames are cracked or detached from the ship's side at the point of weakness. To inspect this area the master must first chip away any rust or cargo residues from the vicinity to ensure that he is inspecting sound steel. The areas where damage is most likely to be found in and around the hold of a bulk carrier are clearly shown in the IACS guide to the subject, a portion of which is reproduced in Fig. 26.2.

Bilge soundings: Unexpectedly high bilge soundings can provide the first warning that damage has occurred, and flooding is taking place. Bilge soundings should be taken daily. In bad weather, if remote readings are not available the sounding should be taken when the ship is hove-to for inspection of the decks. High-level bilge alarms should be maintained in working order and the holds should be checked for flooding if the bilge cannot be pumped dry.

Flood water sloshing: The survivors of several casualties have reported on the odd and unusual motion of the ship when holds were flooded. It seems likely that this odd motion was due to the flood water sloshing in the holds. The motion was described as 'not pitching, not rolling, not corkscrewing, not vibration, but immediately noticeable' (to an experienced seaman). In one case this was the first warning that ship's personnel had that their ship had been damaged.

Other constructive proposals

With the objective of raising the standard of bulk carrier operations and thereby reducing accidents and increasing efficiency, The Nautical Institute's Bulk Carrier Working Group has put foward the following recommendations:

Loading and discharging plans to be landed into the care of authorities: Aboard every bulk carrier a loading plan which complies at every step with classification society stress and loading limits should be completed before commencement of loading and a discharging plan should be completed before the commencement of discharging. A copy of all such plans should be landed in the care of an independent authority, such as the harbour master, port warden, Coast Guard or other administration official. A proper plan sets out the loading or discharging sequence and the corresponding stages in deballasting and states the calculated shear forces and bending moments, and drafts and trim, at each stage. The plan format favoured by The Nautical Institute is to be found inside the back cover.

A procedure should be developed which is similar to that required for grain loading, with a statutory requirement to provide full loading and discharging calculations. This will mean no extra work for ships which are run competently, since such plans are already prepared as a matter of routine.

If loading and discharging plans are prepared and lodged with authorities ashore, there will be a number of benefits. Officers will be required to prepare full plans with shear forces and bending moments calculated at every step in the process and these can, from the first introduction of the procedure, be inspected by the owner's superintendents or port captains to ensure that safe procedures are being followed. The owner's office should keep a file of loading and discharging plans. Once the plans have been passed to the authorities ashore, it will be easier for the ship's officers to resist changes to the programme forced on them by stevedores. Additionally, of course, the ship's loading and discharging history will be available for inspection in the event that she becomes a casualty. If it becomes necessary to amend the programme a copy of the amended programme should be landed to the same independent authority.

Information regarding casualties and dangerous occurrences should be given the widest distribution: This is vitally necessary if the shipping community is to learn from its mistakes. When a ship becomes a casually the circumstances should be the subject of an official enquiry and the findings should be published[115]. This can be particularly useful when there are survivors who can provide an account of events. It is cause for regret that no findings are published in respect of many casualties. The Nautical Institute's Marine Accident Reporting Scheme (MARS) provides the opportunity for the reporting of casualties and incidents and for their publication, in a way that guarantees anonymity. The scheme deserves the widest support.

Methods of electronic sensing of loads and stresses should be developed: The hull stress monitoring system, which uses strain gauges and accelerometers for monitoring structural stress on ships in service, should be developed and used more widely[136 152]. Reliable electronic methods of measuring the tonnages in ships' holds and for detecting flooding as proposed by Lloyd's Register[100] and others[33], should be introduced.

Fitting of voyage data recorders should be encouraged: The fitting of voyage data recorders (black boxes) to assist in the routine recording of information and to provide data for casualty investigations should be encouraged[152]. Responsible ship operators have nothing to lose from the use of these appliances.

Participation in vessel reporting systems should be mandatory[33, 178]: All bulk carriers should participate in the Automatic Mutual Assistance Vessel Rescue System (AMVER) and other similar vessel reporting systems in the areas to which they apply. Ships fitted with the Global Marine Distress and Safety System (GMDSS) should use that also.

Ships should be operated and maintained to a high standard: A high standard of operation and maintenance can be ensured by the use of quality assurance[181], with an effective audit procedure.

Consideration of every aspect of the loss of bulk carriers should continue: An essential part of continued research into losses is consultation between all the parties who have a contribution to make. Seafarers, shipbuilders, shipowners, classification societies, shippers, terminal operators, regulatory authorities, underwriters, receivers and other interested parties should maintain and improve their lines of communication and be informed of developments and plans for the future. As J. M. Ferguson, of Lloyd's Register, has written[176], the dissemination of informed opinion is vital if the likelihood of similar bulk carrier losses in the future is to be reduced.

Good safety practices must be followed: The Nautical Institute's book *The Management of Safety in Shipping*[189] provides guidance as to good management practices.

Bulk carrier personnel must be well trained and well informed: If a bulk carrier is to be operated safely and efficiently her crew must possess a substantial amount of specialist knowledge and experience, as the contents of this book make clear. Such specialist knowledge is best obtained from experienced masters and officers who are accustomed to operating ships safely and to a high standard.

Changes in recruitment and manning have meant that, through no fault of their own, little relevant experience is to be found amongst the officers aboard some bulk carriers. This book is intended to fill that gap and to provide the information necessary for making operational decisions and putting them into effect.

(A summary in Checklist form follows on page 302.)

Sources

22. *Code of Safe Practice for Solid Bulk Cargoes.* International Maritime Organization. 1991.

33. Caro, J. P. & Spink, H. E. 'Hong Kong Administration's View of Bulk Carrier Casualties & Losses'. *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

37. Lynch, R. J. *Steel Industry Bulk Cargoes-a guide for BHP personnel.* BHP Transport Ltd. 1980.

52. Phillips, C. 'Ship Stresses when Carrying Coal.' *Seaways.* October 1991.

57. Berry, Dr F. & Goscinski, J. S. 'Heating of Coals in Transit-Problems, Causes and Solutions.' *Seaways.* 1983.

62. 'Bulker Trimming Purge.' *Lloyd's List.* 20 August 1992.

85. *Ship/Shore Safety Checklist.* International Chamber of Shipping. 1992.

92. Foy, D. B., FNI. 'Disasters at Sea and their Prevention.' *RSA Journal.* December 1987.

95. Akita, Y 'A Challenge to Structural Failure in Ships.' *University of Glasgow Marine & Offshore Safety Seminar.* 1983.

96. *Code of Safe Practice for Cargo Stowage & Securing.* International Maritime Organization, 1992.

97. Richardson, Captain J. 'Total Loss: Some Possible Causes.' *Seaways,* April 1986.

98. Foy, D. B., FNI. 'Bulk Carrier Losses-Unanswered Questions.' *Safe Ship-Safe Cargo Conference.* 1987.

99. Adam, J. C. 'Bulk Carriers-Defect Monitoring.' *Lloyd's Register Seminar.* May 1991.

100. Ferguson, J. M. 'Bulk Carriers-The Challenge.' *Lloyd's Register Seminar.* May 1991.

101. Robinson, D. W. The Bulk Carrier Research Project.' *Lloyd's Register Seminar.* May 1991.

102. Moeyaert, P. 'Circumstances in which Bulk Carriers are Operated.' *Lloyd's Register Seminar.* May 1991.

103. *Foundering of the* Melete. Report No. 34 of Australian Department of Transport & Communications. Undated.

104. *Bulk Carrier Casualties: Rule 5K-Classification & Statutory Requirements.* UKP&I Club. September 1991.

105. Beaumont, J. G. *Bulk carriers: guidance to operators on the inspection of cargo holds.* Lloyd's Register. October 1991.

106. *Casualty Report on the Loss by Grounding of* Petingo. Republic of Vanuatu. Undated.

107. *Bulk Carrier Losses.* Det Norske Veritas. November 1991.

108. Bjorkman, A. *A Stronger & Better Bulk Carrier.* Pamphlet. September 1991.

109. 'Tougher New LR Rules for Bulk Carriers.' *Lloyd's Register Press Release.* November 1991.

110. Isbester, Captain J., ExC, FNI. 'Bulker Casualties-their Causes & Prevention.' *Bulktrans '91.* CS Publications Ltd. May 1991.

111. Reid, D. *el al.* 'Carriage of Steel in Bulk Carriers-Problems of Tanktop Loadings.' *The Work of the Nautical Surveyor.* Nautical Institute. 1989.

112. 'Bulk Carriers-Ships Safe to Sail in?' *Southampton Master Mariners' Club Technical Committee Seminar.* October 1991.

113. 'Bulkers-Side Shell Integrity Questioned.' *Marine Engineers Review. July* 1991.

114. Brooking, M. A. 'Loss of Bulk Carriers-A Naval Architect's Perspective.' *Seaways.* August 1991.

115. Maitland, G. E. C. The Flag State Outlook.' *Seaways.* August 1991.

116. 'Bulk/Combination Carrier Losses-the ABS Position.' *Seaways.* August 1991.

117. Beetham, Captain E. H., FNI. 'Loss of Bulk Carriers.' *Seaways.* May 1991.

118. Robinson, D. W. 'Bulk Carrier Casualties-A Classification Society's View.' *Intercargo Seminar,* Oslo. June 1991.

119. Polemis, S. M. 'Bulk Carrier Losses.' *Intercargo Seminar,* Oslo. June 1991.

120. 'What is the World Coming To?'. Anon. *Journal of Master Mariners of Australia Inc.* Winter 1991.

121. Isbester, Captain J., ExC, FNI. 'Bulk Carrier Casualties and Losses-the Shipmaster's Point of View.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

122. Nunn, A.S. 'Bulk Carriers.' *Intercargo Seminar,* Oslo, June 1991.

123. Bau, Huyng due. 'Bulk Carriers Structural Damage.' *Intercargo /IBJ Seminar.* Hong Kong. October 1991.

124. Kitashima, H. 'Shipbuilder's View of Bulk Carrier Casualties & Losses.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

125. Volkers, N. The Discharging Stevedore's View of Bulker Casualties.' *Intercargo /IBJ Seminar.* Hong Kong. October 1991.

126. Piercy, P. 'Hamersley Iron Shiploading in Dampier.' *Intercargo/IBJ Seminar.* Hong Kong. October. 1991.

127. Jones, D. K. & Roe N. P. 'Bulk Carrier Casualties-an independent consultant's view.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

128. Wakasugi, T. 'Bulker Casualties-The Shipowner's View.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

129. Wingfield, S. 'Bulker Casualties-the Views of Cargo Interests.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

130. *Casualties to Bulk Carriers.* Liberian Shipowners' Council. January 1992.

131. 'HTS-Something for Nothing?' *100A1 magazine.* Issue 3, 1992.

132. Barnet, Captain S.H., MNI. 'What the world has Come to.' *Seaways.* July 1993..

133. 0rbeck F. *Wave-excited hull vibration reduction using hull vibration damper.* Institute of Marine Engineers. March 1992.

134. Corlett, B. J. & Colman, J. C. 'Bulk Carrier Losses-A Naval Architect's Viewpoint.' *MLAANZ Conference 1992.*

135. Isbester, Captain J., ExC, FNI. *The Operation of Bulk Carriers-the Seagoing Perspective.* Royal Institution of Naval Architects. December 1992.

136. Avriii K, & Spence N. *The Harland & Wolff New Bulk Carrier Design for Improved Safety & Longevity.* Royal Institution of Naval Architects. December 1992.

137. 'Special Action to Improve Safety of Older Bulk Carriers.' *GermanischerLloydMagazin.* December 1992.

138. Kruszewski, Dr A. 'Sliding Solid Bulk Cargoes: How to Avoid Them.' *ICHCA Annual Review,* 1992.

139. Isbester, Captain J., ExC, FNI. 'Bulk Carrier Operations.' *Ports & Shipping Seminar.* Karachi, January 1993.

140. Jubb, J. E. M. 'Bulk Carriers-Fatally Flawed.' *Welding & Metal Fabrication.* May 1992.

141. 'Losses of Bulk Carriers during 1990.' *Lloyd's Register Press Release.* January 1991.

142. Foy, D. B., FNI. 'Combination Carriers, Ore Carriers and Sudden Sinkings.' *Safety at Sea.* February 1983.

143. Aksu, S., *et al. Load & Stress Distributions on Bulk Carriers and Tankers in Various Loading Conditions.* Royal Institution of Naval Architects. December 1992.

144. Isbester, Captain J., ExC, FNI. 'Tankers & Bulk Carriers: the Way Ahead.' *Seaways.* February 1993.

145. *Investigation Report, on the Capsizing of the Pusher Vessel* Finn *and the Barge* Baltic *off Hanko.* Accident Report No. 2/1990. Helsinki. 1992.

146. Keith, Captain B. R, MNI. 'Loading of Large Bulk Carriers.' *Seaways.* February 1993.

147. Isbester, Captain]., ExC, FNI. 'Bulk Carrier Practice.' *Seaways.* May 1992.

148. Baillod, Captain R, MNI. Private correspondence with the author. 31 October 1992.

149. 'Framewalk-a system of ladders.' *Seaways.* January 1993.

150. *Bulk Carriers: Guidance and Information to Shipowners and Operators.* International Association of Classification Societies. April 1992.

151. Burton, J. A. *Enhanced Surveys for Tankers and Bulk Carriers.* Lloyd's Register. January 1993.

152. *Safety Aspects of Ship Design and Technology.* House of Lords' Select Committee on Science and Technology (The Carver Committee). HMSO. February 1992.

154. Boyle, Captain P., FNI. 'Bulk Carriers: Operational Aspects which Might Lead to Loss.' *Safe Ship Safe Cargo Conference,* September 1987.

155. Smith, Campbell, BSc, MSc, MCIT, MNI. 'Cargo Handling for Bulk Carrier Fleets.' *Symposium on the Operation of Large Ships.* RINA/NI. March 1976.

156. Lanham, Captain B. D., MNI. 'Bulk Carrier Losses.' *Seaways.* September 1991.

157. Skinner, Dr A. E. *et al.* 'Notes on Bulk Carrier Cargo Liquefaction.' *RINA London branch seminar.* August 1991.

158. *Annex to IMO Resolution A.713 (17).* IMO. November 1991.

159. Isbester, Captain J., ExC, FNI. 'Structural Damage to Bulk Carriers from Block Loading.' *Seaways.* August 1993.

160. Price, Prof. G. Second Wakeford Maritime Lecture. February 1991.

161. 'Solutions-LR's Ship Event Analysis Notation.' *100A1 magazine,* Issue 1 1991.

162. 'Safety Demands Legislation.' *The Motor Ship.* May 1991.

163. 'The Structural Price of Port Pressures.' *Lloyd's List.* 17 September 1991.

164. Hachmann, D. 'Wave Load Rules Unreasonable.' *Lloyd's List.* 9 October 1991.

165. Bjorkman, A. I. C. H. 'Big Bulkers Should be Stronger.' *Lloyd's List.* October 1991.

166. Baillod, Captain R, MNI. 'Shipping's Deep Crisis.' *Seaways.* October 1991.

167. Knight, Captain R., MNI. 'Focus on Bulk Carriers.' *Seaways.* October 1991.

168. Berkley, Captain C., MNI. 'More Research, Less Theorising Please.' *Lloyd's List,* December 1991.

169. Ramwell, Captain D. C., MNI. 'The Bulker Safety Debate Continues.' *MER.* January 1992.

170. Skinner, Dr A. 'Cargo Liquefaction.' *MER.* October 1991.

171. Lloyd, Captain C. M. R., FNI. 'The Flaws in Class Advice on Bulkers.' *Lloyd's List.* 22 January 1992.

172. Noble, J. M., BSc, FNI. 'Bulk Carrier Losses.' *Seaways.* March 1992.

173. Bjorkman, A. I. C. H. 'Weak Bulk Carriers.' *Seaways.* March 1992.

174. Robinson, D. W. 'P & O Voyage Recorder Move Put into Perspective by LR.' *Lloyd's List.* 2 April 1992.

175. Tye, Captain T. J. 'Figures Hide why Bulk Carrier Sinkings are still a Problem.' *Lloyd's List.* 14 August 1992.

176. Ferguson, J. M. 'Informed Opinion is Crucial for Bulk Carrier Safety.' *Lloyd's List.* 19 August 1992.

177. Timmins, I. G. AMNI, FIGS, ACIArb, MCIT. 'The Myth of the Self-Trimming Bulk Carrier.' *Seaways.* July 1993.

178. *Recommendations for Bulk Carrier Safety.* International Association of Dry Cargo Shipowners. January 1992.

179. Foy, D. B., FNI. 'Marine Enquiries & the Public Interest.' *Trans IMarE.* November 1982.

180. Robinson, D. W. 'Bulk Carrier Research-LR Project.' *Seaways.* October 1991.

181. Botterill, Captain G. J., FIGS, FNI. 'Quality Assurance in Ship Management.' /ME. March 1993.

182. *Pilot Study into Loading of Bulk Carriers.* Report from Australia to IMO Maritime Safety Committee. MSC 60/20/5.

183. *Safety of Ships Carrying Solid Bulk Cargoes.* Document submitted by the Government of France to the IMO Maritime Safety Committee. MSC 60/20/8.

184. *Improved Design & Construction Standards for Bulk Carriers.* Document submitted by Hong Kong to IMO Sub-Committee on Design & Equipment. DE35/INF.

185. McDowell, D., AMNI. 'Bulk Carrier Corrosion-Recent Experiences.' *Seaways.* August 1991.

186. 'Incentives Needed to Upgrade Bulker Fleet.' *The Motor Ship.* November 1992.

187. Foy, D. B., FNI. 'Safety & 1985.' *Safety at Sea.* December 1985.

188. *The Management of Safety in Shipping.* The Nautical Institute. 1991.

192. Robinson, D. W. *The Safe Loading & Unloading of Bulk Carriers.* RINA, London Branch. 1993.

193. Hinz, C. 'If Ship Safety Ruled the Waves.' *Bulktrans 93.* CS Publications Ltd.

194. Mckay, Captain B. 'The Canadian Coast Guard Bulk Carrier Inspection Regime.' *Bulktrans 93.* CS Publications Ltd.

195. Bolitho, W. 'The Future Facing Substandard Shipping in the Australian Trade.' *Bulktrans 93.* CS Publications Ltd.

CHECKLIST

SUMMARY of measures for preventing casualties

- ☐ Minimise corrosion within holds by maintaining the condition of paint coatings, rinsing with fresh water and taking extra precautions with corrosive cargoes.
- ☐ Minimise corrosion within ballast tanks by maintaining the condition of paint coatings.
- ☐ Prevent stevedores' damage.
- ☐ Prevent hull contact damage.
- ☐ Report damage and have it surveyed and properly repaired.
- ☐ Avoid local overloading.
- ☐ Provide and use accurate, accessible stability information.
- ☐ Always prepare a full loading/deballasting or discharging/ballasting plan.
- ☐ Keep strictly to loading/deballasting or discharging/ballasting plan.
- ☐ Reduce loading rates when starting an empty hold.
- ☐ Ensure that discharging and ballast changes are planned and executed with the same care as loading.
- ☐ Reject cargo with excessively high moisture content.
- ☐ Ensure that ship is not twisted whilst loading or whilst changing ballast.
- ☐ Close dump valves immediately deballasting is completed.
- ☐ Trim cargo reasonably level to the boundaries of the cargo space.
- ☐ Ensure that cargoes such as steel are well secured.
- ☐ All hatchcovers should be well maintained and carefully secured.
- ☐ All deck openings should be in sound condition and properly secured.
- ☐ Speed should be substantially reduced in adverse weather.
- ☐ Prolonged heavy rolling should be avoided when possible.
- ☐ Sloshing of ballast water in part-filled tanks should not be allowed to occur.
- ☐ Prevent springing by adjustment of course, speed or ballast.
- ☐ Aboard OBOs follow strict procedures to avoid the possibility of gas explosions.

Possible additional measures when a greater margin of safety is required

- ☐ Stay within the at-sea stress limits whilst in port.
- ☐ Increase the number of loading passes.
- ☐ Insist that a maximum loading rate (such as 5,000 tonnes/hour per loader) is not exceeded.
- ☐ Avoid jump (alternate hold) loading, and load all holds.

Summary of additional proposals from The Nautical Institute

- ☐ Land loading and discharging plans into the care of authorities.
- ☐ Give information regarding casualties and dangerous occurrences the widest distribution.
- ☐ Develop and adopt methods of electronic sensing of loads and stresses.
- ☐ Encourage the fitting of voyage data recorders.
- ☐ Make mandatory for bulkers the use of vessel reporting systems.
- ☐ Operate and maintain ships to a high standard.
- ☐ Continue to consider every aspect of the loss of bulk carriers.
- ☐ Follow good safety practices.
- ☐ Ensure that bulk carrier personnel are well trained and well informed.

BULK CARRIER PRACTICE

APPENDICES AND REFERENCE MATERIAL

CONTENTS

RE6INA OLDENDORFF

Owner	Egon Oldendorff (Hong Kong) Ltd.
Builder	Dalian Shipyard of China
Kind of ship	Bulk carrier
Service limitation	Oceangoing (Lakes-Fitted)
Date of launching	27 July 1983
Date of sea trial	1 May 1984
Date of delivery	May 1986
Classification	Lloyd's ✠ 100AI and ✠ LMC Bulk Carrier strengthened for heavy cargo, hold 2 &? 4 may be empty.
Port of registry	Hong Kong.
Principal dimensions	
Length (overall)	about 195.00m
Length (between BP)	183.00m
Breadth moulded	23.00m
Depth moulded	14.30m
Draft designed moulded	10.00m
Summer draft moulded	10.22m
Timber summer draft moulded	10.59m
Ship's form	
Type of ship	Well deck
Type of stem	Raked stem with bulbous bow
Type of stern	Transom type, cruiser stern
No. of decks	One
No. of bulkheads	Seven
Speed, main engine, etc.	
Maximum trial speed (20% dwt)	17.8 knots
Service speed with 15% sea margin	14.5 knots
On full-load condition	
Cruising range at service speed	About 15,000 sea miles
Main engine	B & W 8L55GA
Maximum continuous output (MCO)	10,700 bhp 150 rpm
Continuous service output (CSO)	9,760 bhp 145 rpm
Propeller (keyless type)	Four blade solid type
Material	Mn-Al-Br
Diameter-pitch	5,140 mm-3,392 mm
Tonnage	
Gross	18,121
Net	10,713

Lightweight and deadweight	Weight	LOG (C)	VCG (KG)
Lightweight	8051.0	IS.042	10.119

	Mark	Freeboard	Draft (ext.)	Displacement	Deadweight
Tropical fresh	TF	2.665	10.688	36888	28837
Fresh	F	2.878	10.472	36083	28032
Tropical	T	2.899	10.451	36904	28853
Summer	S	3.112	10.238	36082	28031
Winter	W	3.325	10.025	35263	27212
Timber Tropical fresh	LTF	2.280	11.070	38351	30300
Timber fresh	LF	2.501	10.849	37510	29459
Timber tropical	LT	2.521	10.829	38370	30319
Timber summer	LS	2.742	10.608	37511	29460
Timber winter	LW	3.036	10.314	36375	28324
Timber winter Worth Atlantic	LWNA	3.325	10.025	35263	27212

Loading capacity
Cargo capacity — Grain (holds only) 34,977.9 cu m
Grain (inc. TST) 39,399.5 cu m

REGINA OLDENDORFF

Tank capacity — Water ballast 10,839.9 cu m
Fuel oil (100%) 1,729.2 cum
Diesel oil (100%) 211.0 cum
Fresh water 317.9 cu m

Hot rolled coil loading capacity Coil: T/PCS 1.5 dia x 1.5L x 1.5 T

	Full bunkers		Half bunkers	
	PCS	Weight (T)	PCS	Weight (T)
No. 1 Cargo hold	223	3,345	230	3,450
No. 2 Cargo hold	345	5,175	345	5,175
No. 3 Cargo hold	230	3,450	253	3,795
No. 4 Cargo hold	345	5,175	360	5,400
No. 5 Cargo hold	207	3,105	232	3,480
Total	1,350	20,250	1,420	21,300

Timber loading capacity

	In hold		On deck		Total	
	Cu m	1,000BM	Cu m	l.OOOBM	Cu m	1,000BM
No. 1 Cargo hold	6,463.8	1,201.4				
No. 2 Cargo hold	7,421.9	1,379.5				
No. 3 Cargo hold	5,134.1	954.2				
No. 4 Cargo hold	7,662.0	1,424.1				
No. 5 Cargo hold	6,455.9	1,199.9				
Total	33,137.7	6,159.1	9.697.8	2,075.6	42,835.5	8,234.7

Remark Above figures are based on the following stowage factor
In hold 2.5 T/190ftVlOOO B.M.
On deck 2.5 T/165ftV 1000 B.M.

Grain loading capacity				BEGINA OLDENDORFF	
Item	Fr. No.	Capacity(M³)		Centre of gravity	
		Grain	Bale	G (M)	KG (M)
Cargo hold					
No. 1 Cargo hold	175-219	6,848.0		-65.67	8.36
			6,463.8	-65.63	8.23
Mo. 2 Cargo hold	138-175	7,866.9		36.28	7.79
			7,421.9	-36.28	7.70
Wo. 3 Cargo hold	*112-138*	5,503.5		-10.12	7.76
			5,134.1	-10.14	7.63
No. 4 Cargo hold	74-112	8,060.5		16.42	7.79
			7,662.0	16.42	7.69
No. 5 Cargo hold	40-74	6,699.1		46.08	8.11
			6,455.9	46.22	7.99
Total		34,977.9			
			33,137.7		
Top side tank					
No. 2 Top side tank (P) &? (S)	138-175	1,216.4		-35.87	12.51
No. 3 Top side tank (P) & (S)	112-138	854.8		-9.72	12.51
No. 4 Top side tank (P) &? (S)	74-112	1,253.4		16.84	12.51
No. 5 Top side tank (P) & (S)	40-74	1,097.0		46.47	12.60
Total		4,421.6			

Water ballast tank capacity						
Item		Fr. No.	Capacity	Weight	Centre of gravity	
			(M³)	(MT)	G(M³)	KG (M)
P.P.T.	(C)	219-FE	997.2	1,022.1	-86.38	8.58
No. 1 WBT No. 1 WBT	(P) (S)	175-219	1,031.8	1,057.6	-65.24	1.44
No. 2 WBT No. 2 WBT	(P) (S)	138-175	826.0	846.7	-35.84	1.34
No. 3 WBT No. 3 WBT	(P) (S)	112-138	581.6	596.1	-9.72	1.34
No. 4 WBT No. 4 WBT	(P) (S)	74-112	857.6	879.0	17.00	1.46
No. 5 WBT No. 5 WBT	(P) (S)	39-74	982.8	1,007.4	47.40	1.95
No. 1 TST No. 1 TST	(P) (S)	175-219	879.2	901.2	-63.59	13.10
No. 2 TST No. 2 TST	(P) (S)	138-175	1,216.4	1,246.8	-35.87	12.51
No. 3 TST No. 3 TST	(P) (S)	112-138	854.8	876.2	-9.72	12.51
No. 4 TST No. 4 TST	(P) (S)	74-112	1,253.4	1,284.7	16.84	12.51
No. 5 TST No. 5 TST	(P) (S)	40-74	1,097.0	1,124.4	46.47	12.60
A.P.T.	(C)	AE-12	262.1	268.7	88.72	10.02
Total			10,839.9	11,110.9		
Fresh water tank capacity						
No. 1 PWT	(P)	4-12	97.9	97.9	86.40	13.20
No. 2 FWT No. 2 FWT	(S) (P)	AE-4	125.2	125.2	92.23	13.35
Drinking W.T.	(S)	4-12	94.8	94.8	86.40	13.20
Total			317.9	317.9		

REGINA OLDENDORFF

Item	Fr. No.	Capacity (M^3)		Weight (MT)	Centre of gravity	
		100%	97%		G (M)	KG (M)
Fuel oil (SG = 0.98 t/m^3)						
No. 1 FOT (C9)	138-175	475.6	461.4	452.1	-35.86	0.74
No. 2 FOT (09)	112-138	334.2	324.2	317.7	-9.72	0.74
No. 3 FOT (09)	74-112	488.4	473.7	464.3	16.84	0.74
No. 4 FOT (09)	39-74	324.8	315.1	308.8	44.26	0.74
FO Service T (S)	33-36	34.6	33.6	32.9	65.39	12.05
FO Set T (P & S)	36-39	71.6	69.5	68.1	62.90	12.04
Total		1,729.2		1,643.9		
Diesel oil (SG = 0.85 t/m^3)						
DOT (P 8e S)	25-39	190.4	184.7	157.0	66.24	1.38
DO Service T (S)	29-32	10.3	10.0	8.5	68.72	12.02
DO Set T (S)	29-32	10.3	10.0	8.5	68.72	12.02
Total		211.0		174.0		
Lubricating oil (SG = 0.90 t/m^3)						
LO Storage T (C)	29-35	16.2	15.7	14.1	67.47	0.82
LO Sump T (0)	20-29	24.4	23.7	21.3	73.70	0.82
LO Set T (P)	24-27	23.2	22.5	20.3	72.83	8.65
m/e LO ST (P)	19-24	28.5	27.6	24.9	76.02	8.71
D/G LOT (P)	13-17	6.1	5.9	5.3	81.37	9.28
D/G LO Set T (P)	17-19	3.3	3.2	2.9	79.03	8.18
D/G Clean LOT (P)	17-19	4.1	4.0	3.6	79.06	9.34
Total		105.8		92.4		
Other Tanks						
Oily WT (0)	17-19	16.2			79.06	1.42
Bilge T (0)	12-17	24.2			81.56	1.32
Cool WT (FW) (C)	AF-12	21.6		21.6	85.28	3.53
Cylinder OT (S)	25-28	20.5	19.9	17.90	72.04	12.02

P&O Bulk Shipping

DAMAGE REPORT

Particulars of damage caused by working cargo.

M.S. ______________________ VOYAGE NO__________ DATE __________

1. TIME and DATE OF DAMAGE

2. PORT WHERE DAMAGE OCCURRED
(NAME WHARF OR PLACE WHERE MOORED)

3. NATURE OF DAMAGE (including Cargo) [AND EXACT POSITION]

4. CAUSE OF DAMAGE

5. STATE BY WHOM WORK WAS BEING PERFORMED WHEN DAMAGE WAS SUSTAINED I.E. CREW, WHARF LABOURERS, CONTRACT STEVEDORES ETC.

6. NAME OF OFFICER IN CHARGE AT TIME DAMAGE OCCURRED

7. (1) NATURE OF REPAIRS NECESSARY AND MDR NO.
(2) WHERE AND WHEN TO BE EXECUTED
(3) ESTIMATED OR ACTUAL COST
(4) CODE

DATED THIS __________ DAY OF __________ 19

RESPONSIBILITY FOR THE ABOVE DAMAGE IS HEREBY ADMITTED, THE CAUSE AND EXTENT OF THE DAMAGE AS STATED ABOVE IS CORRECT

SIGNATURE __________________ MASTER

__________________ CHIEF OFFICER

__________________ FOREMAN STEVEDORE OR TERMINAL SUPERINTENDENT

__________________ STEVEDORE AGENTS OR TERMINAL OPERATOR

NOTE:

This report shall be completed in Quadruplicate, original and copies distributed as follows:

ORIGINAL to 1. Senior Technical Assistant

COPIES to 2. Contract Stevedores or Terminal Operators Office

3. Ship's Agents at port where damage occurred

4. Ship's File

HEAD OFFICE:

Code 41050 (Revised 3/85)

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FULL BALLAST CHANGE AT SEA

The vessel: A Cape-sized bulk carrier with five pairs of upper wing tanks (UWTs), five pairs of double bottom tanks (DBs), one ballast hold and a forepeak tank.

	Sequence	% *SF	*BM	Draft (m) FOR'D	AFT	TRIM	GM(m)
1.	Drop Nos. 2, and 4 TTWTs then pump out No. 3 DBs.	91	56	4.56	10.50	5.94	11.51
2.	Pump in Nos 2 DBs and UWTs	89	35	7.27	9.47	2.20	10.13
3.	Drop out No. 1, 3 and 5 UWTs, then pump out No. 3 and 4 DBs.	87	74	6.55	7.43	1.88	13.10
4.	Pump in No. 3 and 4 DBs.	83	38	6.39	8.98	2.59	12.05
5.	Pump out No. 5 DBs.	94	30	6.96	7.27	0.31	12.51
6.	Pump in Nos. 1 and 3 UWTs and No. 5 DBs.	93	33	7.45	8.90	1.45	10.53
7.	Pump out the forepeak and No. 6 hold.	51	56	5.10	7.05	1.95	15.50
8.	Pump in the forepeak and Nos. 4 & 5 UWTs	48	67	6.59	7.41	0.82	12.22
9.	Pump out No. 1 WBTs.	44	46	5.00	8.35	3.35	13.03
10.	Pump in No. 1 WBTs and No. 6 hold. Push up forepeak and all UWTs.	91	41	7.30	10.26	2.96	9.20

*Shear Force (SF) and Bending Moment (BM) expressed as a percentage of the maximum permitted at-sea stresses.

MOTOR-DRIVEN CENTRIFUGAL PUMPS-TRANSCRIPTION OF MANUFACTURERS' INSTRUCTIONS.

1.0 Operation

Operation of the pump after installation or reassembly must be carried out as follows.

1.1 Preparation before operation

a. Open the air vent on top of the casing and fill the casing with water until it comes out of the vent.
b. In the case of reservoir-type self-priming pumps, fill the casing with water after removing the plug on top of the casing. After the pump has been started twice there is no need for further priming if water remains in the casing.
c. In the case of a self-priming pump provided with a vacuum pump, fill the replenishing water tank.
d. Open fully the valve on the suction side of the pump (the 'suction valve'), and close completely that on the discharge side (the 'discharge valve').
e. Make sure that the bearings are lubricated.
f. Turn the pump shaft by hand to make sure it turns smoothly.

1.2 Operation

a. Start the pump motor and stop it after a few seconds. Repeat this several times, to make sure that it is not faulty. When satisfied that it is working properly leave it switched on.
b. When the pump revolutions and pressure have risen, gradually open the discharge valve until the pressure falls to the specified pressure.
c. Avoid running the pump when no water is passing through it, particularly when the pump is fitted with a mechanical seal. Even when a vacuum pump is provided stop the pump after five minutes if the pump has not been primed, and is still running dry.

1.3 Stopping

a. Close the discharge valve.
b. Stop the motor.
c. If the pump stops suddenly during operation, switch off first of all, and then close the discharge valve.

1.4 Precautions during operation

a. Operate the pump as near to design settings as possible.
b. Watch for vibration and noise. If an abnormal condition is seen stop the pump immediately. In particular, for pumps fitted with a mechanical seal, guard against vibration, which will shorten the life of the seal.
c. Watch any rise in bearing temperature. If the bearing housing can safely be felt by hand there is no problem. If it is too hot to hold, measure the temperature with a thermometer. The temperature must be kept below ambient temperature plus 40°C, or liquid temperature plus 20°C, and in any case keep it below 75°C.
d. Adding too much grease will cause overheating so, when replacing grease, add it with the drain plug removed during operation, so that the old grease can be forced out.
e. Allow a small amount of continuous leakage, in the form of drops, through the gland. If the packing is tightened too much, overheating and premature wear of the shaft sleeve will occur.
f. When a mechanical seal is used there should be almost no leakage. If continuous leakage is observed the seal should be checked.
g. Never throttle (close) the valve on the suction side. Adjust the flow by means of the valve on the discharge side.
h. Never operate the pump for more than 10 minutes with the discharge valve closed, otherwise the temperature rise of the liquid in the casing will cause the pump to seize.
i. If the pump reverses when on standby the cause will be leakage from the non return valve.
j. If the pump has an automatic starting and stopping device such as a hydrophore system check the pressure when the pump starts and stops, as well as when it is operating and, if the interval is too short, adjust the air amount, water level, etc.
k. If the pump operates automatically under a central control system, monitor the gauge readings on the control panel board.

1.5 Precautions while the pump is stopped

a. Keep the discharge valve closed.
b. Keep the suction valve closed if the pump is stopped for a long time.
c. In cold regions drain the pumps if they remain stopped.

CALCULATION OF THE EFFECT ON STABILITY OF WATER IN A CARGO HOLD: WORKED EXAMPLE

THERE are times when it would be convenient to wash one or several holds in port, and retain the washings for later discharge in the open sea. Officers should calculate the effect on the ship's stability of retaining washings in such circumstances.

Such calculations will be approximate, because the water depth will be an estimate and the hold dimensions will be approximate, but the calculations can give a good indication if there is a danger of the stability being reduced too much.

Common abbreviations, if not explained below, are to be found in Appendix 10.1.

Assumption

Assume that the *Regina Oldendorff*, in ballast, has 1.0 m of sea water in No. 4 hold, which is the largest hold. Hold dimensions: B=23.0 m, L=31.0m.

To calculate new displacement

Weight of water = (23 x 31 x 1 x 1.025) tonnes = 731 tonnes, with centre of gravity 0.5 m above the tanktop (Depth of double bottom = 1.5 m, so KG of added weight = 2.0 m)

Effect of added weight on displacement:

Ballast displacement:	21,441 tonnes
Added weight	731
New displacement:	22,172 tonnes

Data for new displacement

From hydrostatic tables, at new displacement:

Transverse KM: 9.70 m.

Shift of CG due to new displacement

Shift of position of ship's centre of gravity as a result of the weight of water in No. 4 hold:

GG_1 = w x d/(W + w), where

GG_1 = shift of the position of the centre of gravity, in metres.
w = is the added weight, (731 tonnes)
d = is the distance between the centre of gravity of the weight added, and the centre of gravity of the ship.
W = is the initial displacement (21,441 tonnes).

From ship's loading manual for ballast condition, KG = 8.23 m.

d = Ship's KG — Hold water KG = 8.23 - 2.0 = 6.23 m.
GG_1 = 731 x 6.23/(21,441 + 731) = 0.20
New KG = KG_1 = 8.23 - 0.20 = 8.03 m.
KM - KG_1 = G_1M = 9.70 - 8.03 = 1.67 m

Effects of free surface in tanks and hold

The calculation so far has taken account of the additional weight of water in No. 4 hold, but the correction for the additional free surface has still to be applied.

Virtual rise of CG (G_1G_0) = FSM/Displacement
(For the derivation of this formula see below)

FSM = $1.025.LB^3/12$, where

L = length of hold = 31 m, B = breadth of hold = 23 m.

FSM for water in hold (tonnes-metres) = $1.025 \times 31 \times 23^3/12$	= 32,217	
FSM for ballast & bunker tanks	= 8,516	(from loading manual)
Total FSM	= 40,733	tonnes-metres.

G_1G_0 = FSM/Displacement (t) = 40,733/22,172 = 1.83 m.
Fluid GM = G_0M = $G_1M - G_1G_0$ = 1.67-1.83 = -0.16m.

Conclusions

In departure ballast condition, with 1.0 metre of water in No. 4 hold, the calculated departure GM of the *Regina Oldendorff is* -0.16 m.

The calculation is an approximate one and includes a generous allowance for free surface in the topside tanks. However, it is clear that the ship's stability does not allow her to put to sea with 1.0 metre of hold washings in the largest hold on the ship. This demonstrates the importance of making the calculation.

However, the GM of many bulk carriers in ballast is substantially greater than that of the *Regina Oldendorff*, and individual holds often occupy a smaller part of the ship's hull. The calculation should always be completed, and in many cases it will show that hold washings can be retained in one hold.

Derivation of formula: Virtual rise of CG = FSM/Displacement

Virtual rise of CG (G_1G_0) = $LB^3/12V \times d_1/d_2 \times 1/n^2$ . . . . (1)

V = volume of displacement = displacement (tonnes) x d_2 . . . . (2)

where

L = length of compartment; d_1 = density of liquid in compartment

B = breadth of compartment; d_2 = density of water ship floats in

n = number of longitudinal subdivisions in compartment.

Substitute for V in (1):

$$\text{Virtual rise of CG} = \frac{LB^3 \times d_1}{12 \times \text{Displacement (t)}} \times \frac{1}{n_2}$$

However, $1/n_2 = 1$ when the hold is not subdivided, and $d_1 = 1.025$ when the hold contains sea water, so

$$\text{Virtual rise of CG} = \frac{1.025 \times LB^3}{12} \times \frac{1}{\text{Displacement (t)}}$$

But

$$\frac{1.025 \times LB^3}{12} = \text{free surface moments (FSM)}$$

So virtual rise of CG (G_1G_0) = FSM/Displacement

Appendix 8.6

Change of Trim with Change of Density: Worked Example

For the Regina Oldendorff *the calculation is as follows:*

From ship's hydrostatic data:	Draft (m)	Displ (m^3)	LCB
Initial draft	10.24	35,000	-3.494
New draft (see calc. below)	10.47	35,875	-3.372

If the *Regina Oldendorff* is initially trimmed even keel and floating at her summer draft in salt water, and then passes into fresh water her draft will increase. To calculate the new draft:

$$\text{New displacement } (m^3) = \frac{\text{Old density} \times \text{Old displacement } (m^3)}{\text{New density}}$$

$$\text{New displacement } (m^3) = \frac{1025 \times 35{,}000}{1000} = 35{,}875 \text{ m}^3$$

From the hydrostatic data, the draft which corresponds to a volume of displacement of 35,875 m^3, is 10.47 m.

New draft: 10.47 m

$$\text{Trim change} = \frac{\text{Displacement (tonnes)} \times (LCB_1 - LCB_2)}{MCTC}$$

$$\text{Trim change} = \frac{36{,}090 \times ([-3.494] - [-3.372])}{486.38} = -9.05 \text{ cm}$$

Naming the trim

To decide whether the change of trim is by the head or by the stern keep strictly to the algebraic sign convention, which gives a negative (-ve) answer in this case, as shown above. In the stability documents used on board the *Regina Oldendorff* negative signs signify a trim by the head.

Alternatively, remember this simple rule:

If the position of the CB moves aft the change of trim is by the head. (In the example the CB moves from 3.494 m forward of midships, to 3.372 m forward of miships-i.e., it moves aft.)

Loading Orders for a Complex Cargo

THE following cables were sent to the master of a Panamax bulker, and provide an illustration of the complicated range of alternative programmes that the master may have to consider. They involve loading in brackish water (BW); bunkering in Tampa, and/or Balboa or Long Beach, or China or Honolulu; working to limiting drafts in Tampa, the Panama Canal and the Chinese discharge port; and loading up to two different grades of cargo in up to three different berths.

Words have been run together in the text to reduce the cost of transmission, since each block of ten letters or less is charged as a single word.

From charterers to master, Message No. 1:
PLS/ADVISE CARGOLIFT EX/TAMPA ON/38FT BW AND/33.5FT BW/FOR PHOSROCK CARGO/TO CHINA/STOP

WE/WILL BUNKER/VSL AFTER LOADING TAMPA/AT 43FT/BW/AT ANCHORAGE PLS/ADVISE BUNKERS NEEDED/FOR AA/TAMPA LONG/BEACH BB/TAMPA CHINA CC/TAMPA CHINA LONG/BEACH PLS/ALSO ADVISE/HOW MUCH/CARGO WOULD/BE SHUT/OUT AT 38FT BW DUE/PANAMA CANAL/DRAFT OF/39FT 06IN IF/TAKE BUNKERS/IN PLANS/BB AND/CC RGDS

(The master is asked to advise the tonnage of phosphate rock which the vessel can carry to China, loading in Tampa to a draft in brackish water of 38ft, or of 33.5ft. Vessel will be bunkered at anchorage, where draft is 43ft in brackish water, after loading. The master is asked to state how much bunkers he requires to take the ship to three alternative future bunkering ports. He is also asked to advise how much cargo will be displaced (shut out) by the extra bunkers required for plans BB and CC.

From charterers to master, Message No. 2:
FROM etc. CONFIRM NEXT/VOY TAMPA/TO CHINA/VIA PANAMA CANAL/WITH PHOSROCK SPEED/14KT PLS/ADVISE BUNKER RQMTS/FOR AA/BB/CC OF/OUR EARLIER MSG/BASIS 14/KNOTS TAMPA AGENTS/ARE etc/STOP

SEND/ETA ON/RECEIPT THIS/CABLE AND/7/4/2 I/DAYS PRIOR ARRIVAL/TO (agents) RGDS

(The voyage is confirmed and bunker requirements for three options are requested, as are ETA messages.)

From charterers to master, Message No. 3:
TAMPA/NOW HAS/A TIDAL BERTH/WHICH ALLOWS LOADING FROM/38-41FT/BW1.016 STOP/BASIS 39FT06/INFM TRANSIT DRAFT PANAMA CANAL/AND BEARING IN/MIND 11.85M SWAD/CHINA PLS ADVISE CARGO/LIFT BASIS/AA BUNKER BALBOA/TO REACH/CHINA BB/BUNKER LONG/BEACH CC/BUNKER HONOLULU PLS/ADVISE BUNKERS NEEDED TAMPA/TO REACH/HNLU ALSO ADVISE IF/PUT/NO BUNKERS/ON BOARD/TAMPA AND/WHEN GET/TO BALBOA BUNKERS SUDDENLY UNAVAIL COULD/VSL SAFELY REACH/LONG/BEACH USING MDO/AS WELL/AND ALL/GOING WELL ENROUTE TAMPA-LB AT/14KTS WHAT/WOULD IFO/MDO ROBS/BE ON/ARRIVAL LONG/BEACH/STOP/

WOULD APPRECIATE YOUR/BEST EFFORT/TO KEEP/WEIGHT OF/LUBES STORES WATER/AS LOW/AS POSSIBLE UNTIL/AFTER CANAL/STOP

PLS/NOTE HOLDS/MUST BE/IN GRAIN/CLEAN CONDITION FOR/PHOS ROCK/STOP

AT/THIS TIME/ROCK SUPPLIERS PLANNING TO/LOAD/2 GRADES/AT 3/BERTHS EACH/GRADE 25000/10 PCT MOLOO/WITH NATURAL SEPARATION EACH/BERTH MAY/HAVE BOTH/GRADES STOP/

PLS ADVISE/IF NEED/SOME CERTAIN AMOUNT OF/CARGO AT/1ST/TWO BERTHS/TO PREVENT EXCESSIVE SHEAR STRESS/RGDS

(Tampa has a berth with a draft of 38-41ft and density of 1.016.

Limiting drafts are 39ft6in in fresh water for Panama Canal, and 11.85 metres salt water arrival draft for China. Various bunker options are proposed and master's advice/requirements requested.

Extra weights are to be kept to a minimum, and holds are to be clean enough for grain, before loading phosphate rock.

Ship may load two grades at each of three different berths, each grade to be 25,000 tonnes (10 per cent more or less in owner's option). The master is invited to state whether he requires any minimum tonnage at each of the first two berths, to avoid overstressing the vessel.)

From charterers to master, Message No. 4:

FROM agent, etc. PROGRAM/AS FOLLOWS: 1ST/BERTH LOAD 23500/MT 2ND/BERTH LOAD/CARGO TILL/REACH 34FT/BWEK LAST/BERTH LOAD/CARGO TO/REACH/MAX 55000MT AVAILABLE FROM SUPPLIERS STOP

AT/LAST BERTH 41PT/BW AVAILABLE BUT/THEN MUST/WAIT FOR/TIDE TO/GET/OVER 38PT/MLW MUCD/BAR/STOP

IP/PUT 125MT DO/ON BOARD/PLS ADVISE/HOW MUCH/IPO CAN/TAKE AND/STILL ARRIVE PANAMA 39FT06/INFW STOP

AT/PRESENT WILL/LOAD ONLY/ONE GRADE/BUT SUPPLIERS WANT/TWO BILLS/OP LADING/IP POSSIBLE PLS/DESIGN STOWPLAN SO/ONLY EMPTY/HOLDS ARE/LOADED AT/LAST BERTH/AND IT/IS/STILL POSSIBLE TO/HAVE NATURAL SEPARATION POR/2/LOTS OP/S5000 10PCT/MOLOO PLS/ADVISE STOWPLAN REGARDS

(Programme is: load 23,500 tonnes in the first berth. In the second berth load until a draft of 34ft even keel in brackish water (BWEK) is reached. In the third berth load to 55,000 tonnes.

Last berth has a depth of 41ft in brackish water, but departure is controlled by the tide, as there is a mud bar with a depth, at mean low water (MLW) of 38ft.

The master is asked to state the maximum intermediate fuel oil (IPO) he can take without exceeding the limiting draft at the Panama Canal, after he has taken 125 tonnes of diesel oil (DO).

To meet a requirement for two bills of lading the master is requested to plan the loading to provide natural separation of two parcels of about 25,000 tonnes of cargo, and to reach the final loading berth with empty holds for the final delivery of cargo. He is asked to advise the intended stowage plan.

Appendix 9.2

Maximum Tonnage Permitted in Hold

WHEW bulk carriers are designed, a maximum tonnage is assumed for each hold, and the ship is then built with sufficient strength to carry the intended tonnage. A ship's loading plan should never propose the loading of a tonnage which exceeds the maximum permitted tonnage.

In recent years it has become a requirement that the maximum permitted tonnage for each hold is stated in the loading manuals of new ships, and this information is given in the manuals of some older vessels, too. There are, however, many loading manuals in which the maximum permitted tonnages are not stated. Despite this the danger of overloading a hold when carrying closeweight cargoes such as iron ore cannot be ignored. It may arise when the ship is loaded to tropical marks, and is carrying a small bunker tonnage, or when several grades of cargo are being carried.

There are several ways in which the master can ensure that no hold is overloaded.

1. When permissible loadings are stated in the loading manual they must not be exceeded.
2. Any loading which appears amongst the standard loadings in the ship's loading manual is permissible. A loading in which cargo tonnages are increased or redistributed, and bunker tonnages are reduced, as compared with the standard loading, may not be permissible.
3. If no tanktop loadings are stated in the manual, the formula given in the Bulk Carrier Code[22], para. 2.1.2.2 can be used. Unfortunately, however, it is of little practical assistance since it appears to be applicable to homogeneous loading conditions and not alternate loading conditions. It is a 'safe' formula, which is usually found to give a lower value than the one allowed by the classification society.
4. When considering the heavy loading of a hold aboard a ship which has insufficient information about maximum permissible hold loadings the master should, through his owners, request advice from the classification society.

It is not possible to give any general advice to enable a master to resolve this question without reference to the classification society, because both longitudinal strength and local strength must be considered when the maximum permitted hold loading is calculated.

When a hold is being heavily loaded several considerations should be kept in mind.

1. Whilst the classification societies normally allow a margin for error when stating the maximum permitted load for a hold, the margin is usually very small and should never be relied upon. Planned hold loadings should never exceed the hold loadings given in the approved loading manual.
2. The maximum permitted tonnages are calculated on the assumption that the cargo will be peaked in the hold although, in practice, it is recommended that cargo should be trimmed reasonably level to the boundaries of the space.
3. The maximum tonnage which can be placed in a hold with safety may be considerably reduced when the ship is being block loaded. The separate notes on block loading (Appendix 9.4) should be studied where applicable.

NAUTICAL INSTITUTE CARGO OPERATIONS CONTROL FORM

Programme version No: 1 (LOADING)	No of Loaders / ~~Dischargers~~: ONE		
Ship: "CAPESIZE"	Load / Disch. Port: BOCA GRANDE	Max Draft Available (HW): 17.88	Max Airdraft in Berth:
Assumed SF of Cargo: FINES 14 cf/mt, LUMP 14 cf/mt	Ballast Pumping Rate: 4000 t/h		
Date Commenced:	Max Sailing Draft: 17.88	Min Draft Available (LW): 9.42	Dock Water Density: 1.025
Last Cargo: IRON ORE/COAL	Load / ~~Disch~~ Rate: 4500 t/h		

	11	10	9	8	7	6	5	4	3	2	1
Tonnes			14765	17000	17382	16382	16382	16900	15382	15766	13050
Grade			FINES	LUMP	LUMP	LUMP	LUMP	FINES	LUMP	LUMP	FINES

Totals: Grade: FINES: 44706 Tonnes Grade: LUMP: 98294 Tonnes Grade: Tonnes Total: 143,000 Tonnes

Pour No	Cargo Hold No	Cargo Tonnes	Ballast Operations	Time Req'd (Hrs)	Comments	Calculated Values Draft F	Calculated Values Draft A	Maximum BM*	Maximum SF*	Calculated Values Air Draft	Calculated Values Draft Mid	Trim	Observed Values Draft F	Observed Values Draft A	Observed Values Draft Mid
1	4	10000	GO 1 & 3 UWTs	2.22	Fines	9.99	10.77	73	49		10.38	0.78			
2	1	7000	GO Upper F Peak, PO 2 Hold	1.56	Fines. Changeover 2 Hold	10.14	10.48	66	53		10.31	0.34			
3	9	8000	GO 5 UWTs, PO A Peak	1.78	Fines	9.42	12.15	63	59		10.79	2.73			
4	4	6900	PO 1 DBs	1.53	Fines	10.12	12.50	80	43		11.31	2.38			
5	9	6756	PO 5 DBs	1.50	Fines	9.56	13.74	80	45		11.65	4.18			
6	1	6050	PO Lower F Peak. GO 2 UWTs	1.34	Fines	9.61	13.57	75	49		11.59	3.96			
					Change grade to Lump										
7	7	10000	GO 6 Hold to 50%	2.22	Lump	8.94	14.38	-58	55		11.66	5.43			
8	5	10000	PO 6 Hold	2.22	Lump	9.63	13.63	-67	49		11.63	4.00			
9	7	7382	Educt 6 Hold	1.64	Lump. Changeover 6 Hold	9.57	15.24	-64	47		12.41	5.67			
10	3	10000	PO 2 & 3 DBs	2.22	Lump	10.41	14.65	-49	38		12.53	4.24			
11	8	10000	GO 4 UWTs	2.22	Lump	9.58	16.66	-50	43		13.12	7.08			
12	5	6382	PO 4 DBs	1.42	Lump	10.28	16.24	58	37		13.26	5.96			
13	8	6000	Educt as required	1.33	Lump	9.90	17.88	53	38		13.89	7.98			
14	2	8000	Educt as required	1.78	Lump	12.51	16.68	-65	46		14.60	4.17			
15	6	9000	Educt as required	2.00	Lump	13.14	17.80	42	-21		15.47	4.66			
16	2	6000	Educt as required	1.33	Lump	15.06	16.98	33	-14		16.02	1.92			
17	6	7382	Educt ballast lines	1.64	Lump	15.59	17.88	48	-30		16.74	2.29			
18	3	5382	Shut down ballast	1.20	Lump	16.95	17.54	44	-27		17.02	0.59			
					Trim check										
19	8	1000		0.22	Lump	16.94	17.72	49	-30		17.33	0.79			
20	2	1766		0.39	Lump	17.51	17.51	46	-27		17.51	0.00			
					Draft survey										
					Seagoing condition:	17.51	17.51	62	-36		17.51	0.00			
			*KEEP CARGO TRIMMED LEVEL IN HOLDS *KEEP SHIP UPRIGHT AT ALL TIMES*												
TOTAL:		143000													

Signed on behalf of Stevedores: A Wilson Signed Chief Mate: J Smith

NO DEVIATION FROM ABOVE PLAN WITHOUT PRIOR APPROVAL OF CHIEF MATE
*BM & SF to be expressed as % of maximum permitted values.
Pours to be numbered 1A, 1B, 2A, 2B, etc when using two loaders.
Abbreviations: PI = Pump In GI = Gravitate In F = Full
PO = Pump Out GO = Gravitate Out MT = Empty

All entries within the box must be completed as far as possible. The entries outside the box are optional

NAUTICAL INSTITUTE CARGO OPERATIONS CONTROL FORM

Programme version No: 1 (DISCHARGING) | No of ~~Loaders~~ / Dischargers: TWO

Ship: "CAPESIZE"	Load / Disch. Port: JAPAN	Max Draft Available (HW): 17.35	Max Airdraft in Berth:	Assumed SF of Cargo:	Ballast Pumping Rate: 6000 t/h
Date Commenced:	Max Sailing Draft: 11.30	Min Draft Available (LW): 7.59	Dock Water Density: 1.025	Last Cargo: COAL 2,4,6,8 / IRON ORE 1,3,5,7,9	~~Load~~ / Disch Rate: 1,250 t/h per grab.

	11	10	9	8	7	6	5	4	3	2	
Tonnes			14765	16910	17382	16382	16382	16900	15382	15470	13050
Grade			FINES	LUMP	LUMP	LUMP	LUMP	FINES	LUMP	LUMP	FINES

Totals: Grade: FINES: 44706 Tonnes Grade: LUMP: 97908 Tonnes Grade: Tonnes Total: 142,614 Tonnes

Pour No	Cargo: Hold No	Cargo: Tonnes	Ballast Operations	Time Req'd (Hrs)	Comments	Calculated Values: Draft F	Draft A	Maximum BM*	Maximum SF*	Calculated Values: Air Draft	Draft Mid	Trim	Observed Values: Draft F	A	Mid
1A	2	15470	GI 1 & 2 DBs. PI 2 UWTs	13.2	Lump. 2 & 6 Holds MT	13.82	16.29	-72	48			2.47			
1B	6	16382													
2A	5	10000	GI 4 DBs. PI 4 UWTs	8.0	Lump.	13.44	14.54	71	56			1.10			
2B	8	10000													
3A	3	9000	GI 3 DBs.	7.2	Lump.	12.19	13.68	77	78			1.49			
3B	7	9000													
4A	5	6382	GI 5 DBs.	5.5	Lump. 5 & 8 Holds MT	12.67	15.22	68	38			2.55			
4B	8	6910	PI 6 Hold to 0.5m ullage												
5A	3	6382		6.7	Lump. 3 & 7 Holds MT	11.05	13.94	-91	59			2.89			
5B	7	8382													
			Draft Survey, &	change grade to Fines											
6A	1	6000	PI 1 & 5 UWTs	4.8	Fines	9.75	14.01	83	42			4.26			
6B	9	6000													
7A	4	8756		7.0	Fines	9.38	10.64	80	52			1.26			
7B	9	8756													
8A	1	7050	GI & PI Lower FPeak	6.5	Fines	7.59	11.30	84	-82			3.71			
8B	4	8144	PI Upper FPeak & 3 UWTs												
					SEAGOING CONDITION:	7.59	11.30	84	-82			3.31			
TOTAL:		142614													

① Please empty No 6 Hold and leave as clean as possible as soon as possible. This will then be changed over and used for ballast during stage 4.

② Grab and bulldozer blades must not be allowed to strike the ship's structure. Please instruct drivers to take the utmost care.

③ Please note there are bilge and eductor plates in the after corners of each hold. Take great care in these areas.

Signed on behalf of Stevedore: A Wilson Signed Chief Mate: J. Smith

All entries within the box must be completed as far as possible. The entries outside the box are optional

NO DEVIATION FROM ABOVE PLAN WITHOUT PRIOR APPROVAL OF CHIEF MATE

*BM & SF to be expressed as % of maximum permitted values.

Pours to be numbered 1A, 1B, 2A, 2B, etc when using two loaders.

Abbreviations. PI = Pump In GI = Gravitate In F = Full

PO = Pump Out GO = Gravitate Out MT = Empty

Appendix 9.3 (2)

STRUCTURAL DAMAGE TO BULK CARRIERS FROM BLOCK LOADING

THE International Association of Classification Societies (IACS) has informed The Nautical Institute that a number of large bulk carriers have in the recent past experienced structural damage affecting the cross-deck structure which separates adjacent cargo hatchways at the upper deck level. The damage was due to the load distribution adopted.

IACS state that in all cases the class-approved alternate hatch load distribution had been ignored, and non-standard load distribution had been used. A feature of all the faulty loadings was that two adjacent holds were heavily loaded. The use of two or more heavily loaded adjoining holds, with the adjacent holds empty, is known as block loading.

The Nautical Institute has seen no details of the loadings of the ships in question, but there are several possible reasons for the use of block loading. Such a loading may have been adopted to provide segregated stowage for two or more separate parcels of cargo.

Shipmaster members of The Nautical Institute have, in the past, proposed block loading for two other reasons. The first is to avoid overloading individual holds when the ship is jump loading to Tropical marks and/or carrying only a small quantity of bunkers. In those circumstances the combined maximum permitted tonnage for the ore holds may not be enough to bring the ship to her marks. To a mariner it may seem logical to put the additional tonnage in one of the intervening holds, thus creating a block of three adjoining holds loaded with ore. However, this practice may induce local strength problems particularly if, having made the decision to load an additional hold, the tonnage in it is increased to what is considered a 'worthwhile' value.

The second reason advanced by shipmasters is to reduce the values of shear forces and bending moments by changing a five hatch load into a six or seven hatch load. Many shipmasters believe that excessive static and wave-induced shear forces and bending moments have broken ships and caused their loss and some of them, in discussions on the subject of bulk carrier losses, have advocated reducing static shear forces and bending moments by loading one or two additional holds. In fact it seems that such action, whilst reducing shear forces and bending moments, may increase local loading to an extent which is not acceptable.

The problem with block loading, LAGS states, is one of local strength: the ship's longitudinal strength was satisfactory in each of the cases where damage occurred, and the routine calculations for longitudinal strength would have given no warning that damage might occur.

IACS emphasise rules which, if followed, should prevent damage.

1. The maximum permissible load for each hold must never be exceeded.
2. When using an alternate hatch loading, the loading condition and distribution approved by the relevant classification society is to be used.
3. When planning to deviate from the approved alternate hatch loading by loading additional hatches, guidance should be obtained from the relevant classification society. Any non-homogeneous loading condition and distribution which is not shown in the ship's approved loading manual has not been approved, and may be unsafe.

Some ships are provided with standard loading conditions which feature block loading. In such cases the loadings have been checked and approved by the classification society, and can safely be used. If the ship's loading manual does not show the particular block loading that a master wishes to use, The Nautical Institute strongly recommends that he should follow the IACS recommendation and obtain guidance, through his owners, from the classification society.

A better feel for the factors involved may be gained from guidance recently given by one of the principal members of IACS to the operator of a class of bulk carriers, although it must be emphasised that the factor quoted was calculated for a particular group of ships, and does not apply to any others. The guidance was as follows:

> *Where block loading is required, ie adjacent holds loaded in association with one or more remaining holds empty, the total maximum permissible load in the two adjacent holds should not exceed 1.25 x maximum corresponding alternate hold load with the double-bottom tanks empty.*

In other words, if the maximum cargo allowed in holds Nos. 3, 5 and 7 is S4,000 tonnes per hold, and if a closeweight cargo is to be block loaded in Nos. 3, 4 and 5, the maximum total permitted in No. 3 + No. 4, or in No. 4 + No. 5 is 24,000 x 1.25 (ie, 30,000 tonnes), when the double bottom tanks are empty. This applies when the ship is block loaded, despite the fact that the maximum permitted loading of No. 4 hold is normally 17,000 tonnes.

IRON SOMERSBY (1976) LOADING PROCEDURE

Run	Hold	Tonnes	Ballast
			After draft survey dump all wing tanks.
1	9	8,000	Pump No. 5 hopper (Pt &? Stbd).
2	5	10,000	Pump Wo. 3 hopper (Ft & Stbd).
3	3	10,000	Pump Wo. 2 and Wo. 1 hoppers (Ft &? Stbd).
4	7	12,000	Strip as required.
5	1	12,000	Ballast out (8 hours) Draft check
6	9	7,000	(If ballast is slow, pouring may continue to end of Run 9, when loading
7	5	8,000	should cease until stripping is completed).
8	3	8,000	
9	7	6,000	
10	1	5,500	
11	9	7,000	
12	5	4,700	Draft check
13	3	S,500	
14	7	3,000	
15	3	1,000	
16	7	1,300	
		106,000	

One loader at 6,000 TPH takes around 18 hours.

Two-loader operation

Loader No. 1				Loader No. 2			
Run	Hold	Time	Elapsed Time	Elapsed Time	Run	Hold	Tonnes
1	9	8,000	0120	0140	2	5	10,000
4	7	12,000	0320	0320	3	3	10,000
6	9	7,000	0430	0520	5	1	12,000
7	5	8,000	0550	0640	8	3	8,000
9	7	6,000	0650	0740	10	1	5,500
11	9	7,000	0800	0820	12	5	4,700
14	7	3,000	0830	0845	13	3	2,500

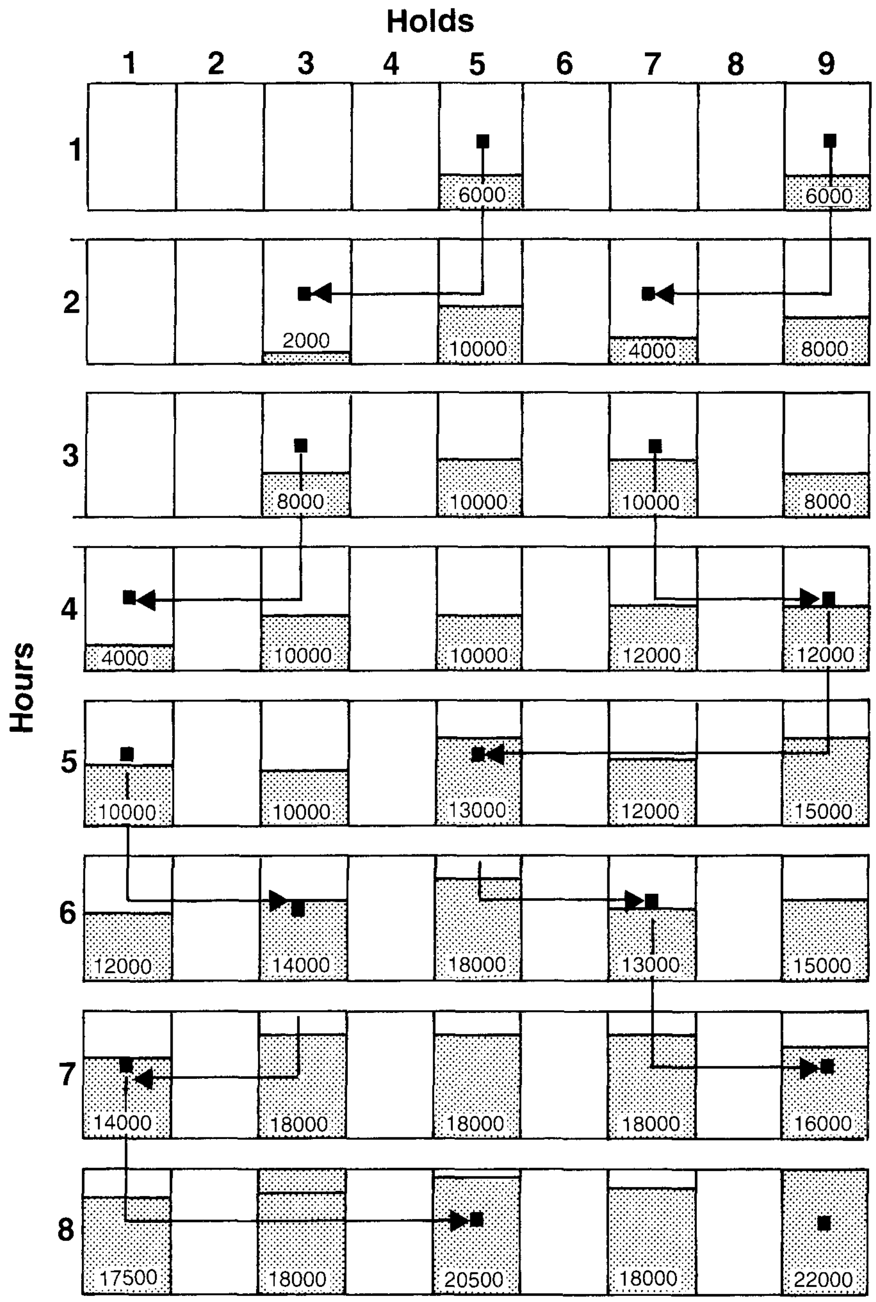
Identical ballast sequence is followed.

On the following page is a diagrammatic explanation of the two-loader operation, in an hour by hour sequence.

(Courtesy BMP)

Two Loader Operation

■ = Position of loader



(Courtesy BHP)

TRIMMING POUR-TWO-HOLD, 3,000 TONNE DWT, MINI BULKER

RESERVE about 300 tonnes for trimming to achieve the required draft. To calculate the trimming pour proceed as follows.

1. Read draft amidships, port and starboard, and take mean.
2. Deduct mean draft from intended loaded draft. (Intended loaded draft should be corrected for dock water density, consumption on passage to open sea, etc.)
3. Tonnes per centimetre immersion (TPC) for this vessel at loaded draft is almost exactly 10, so when a draft increase of 29 cm is required, for example, 290 tonnes of cargo must be loaded.
4. From forecastle head read the forward draft, compare it with draft amidships and from this calculate the present trim. Often it is not easy to read the after draft and even when it is easy to read the draft aft on one side it is not easy to read on the other side, to take the mean, so calculations are best if based upon forward draft plus drafts amidships, port and starboard.
5. The following allowances for loading in different positions in No. 1 hold have been taken from the trimming data of the vessel used for this example. They are used to select the position to be used for the final pour:

100 tonnes at Position:	**Change of Trim (cm)**
Position One	46
Midlength of No. 1 hatch	34
Halfway between midlength and Two	27
Position Two	20
After coaming of No. 1 hatch	15

6. A typical calculation:

Final mean draft required:	5.45m (corrected for density)		
Mean draft at trimming:	5.16		
Difference:	0.29 ... to load 290 tonnes		
At trimming, draft forward	4.51		
Mean draft at trimming	5.16		
Half trim:	0.65	... full trim	1.30
		... trim required	0.50
		Trim change required	**0.80**

From table (above) 290 tonnes at Halfway: 2.9 x 37 = 78.3

7. To keep a check on how the loading is progressing it is helpful to do a succession of calculations like the above, during the last couple of hours of loading, but without stopping loading.

QUANTITIES REQUIRED FOR FINAL TRIMMING

Example based upon a Panamax **bulk** carrier

NB: Trim by head, and trim change toward head: +ve (positive)

		For'd		Aft		Midships	Trim		Mean²
Present Drafts:	P	*.13.41.*	P	*.13.51.*	P	*.13.46.*			
(Corrected)	S	*.13.41.*	S	*.13.51.*	S	*.13.46.*			
Means	F	*.13.41.*	A	*.13.51.*	Mid.	*.13.46.*	. *–0.10.*		
Mean of Means ('Mean²')		[(F+A+6M)/8]							*.13.46.*
Required Draft		***.13.72***		***.13.72***		***.13.72***	***.0.00.***		***.13.72.***
Trim change required (cm)						(+/-)	.+10.	cm	(A)
Mean sinkage required:									.0.26.
		@ TPC	**.68.**	required to load .1768. tonnes					(B)

From trim tables:

1000 tonnes in No. **.3.** (a for'd hold), changes trim +**.47.5** cm (C)

1000 tonnes in No. **.7.** (an after hold), changes trim —**.27.0** cm (D)

Let X be tonnes to be loaded in for'd hold

X = [1000A - DB]/[C - D[??]

Substitute for A, B, C and D in the above, taking care to use the correct sign for each of the values, and solve for X.

X = [1000(+10) - (**27.0**)(1768)]/**[47.5 – (–27.0)]**

= [10,000 + 47,736]/**[47.5 + 27.0]**

= 57,736/**74.5**

= 775

X = ..775.. tonnes & (B - X) = ..993.. tonnes

Check (from trimming tables/

X tonnes	=	*.775.* in hold No. **.3.** causes trim	*+ 0.30.*F	*–0.07.* A
(B-X) tonnes	=	.993. in hold No. **.7.** causes trim	*+ 0.01*F	*+ 0.28.* A
Trim change			*+ 0.31.*	*+ 0.21*
Present draft			*13.41.*	*13.51.*
Final draft			*13.72.*	*13.72.*

Items shown in italics are to be entered by the user

Items shown in ***bold italics*** can be precomputed and pre-entered.

VARIETY OF ABBREVIATIONS FOR TERMS USED IN STABILITY

These abbreviations have been taken from the loading manuals of five ships, and from several other publications.

	Ship A	Ship B	Ship C	Ship D☆	Ship E	UK DTp	RINA	Derrett
Stowage factor in cubic metres per tonne (or cubic feet per long ton)		SF		SF	SF			
Specific gravity	SG	SG			SG	SG	γ	SG
Volume of Displacement in cubic metres					V		∇	$V, \underline{\nabla}$
Displacement in tonnes	Dispt	W, Δ		Δ	D	Displ't	Δ	W, Δ
Tonnes per centimetre immersion, in tonnes		TPC	TPC	TPI	TPC	TPC		TPC
Moment to change trim one centimetre, in tonnes-metres		MTC	MTC	MTI	MTC	MCTC		MCTC
Centre of buoyancy from midships (†aft), in metres	LCB	LCB, ⦶B		LCB	MB	LCB, ⦶B	†LCB	
Centre of flotation from midships (‡aft), in metres	LCF	LCF, ⦶F		LCF	MF	LCF, ⦶F	‡LCF	
Centre of gravity from midships, in metres	LCG	⦶G	LCG	MG	LCG, ⦶G			
Centre of gravity above baseline, in metres	KG	KG	KG	KG	VCG, KG	KG	$\overline{KG}$	KG
Longitudinal distance from the longitudinal centre of buoyancy to the longitudinal centre of gravity, metres		BG		BG	BG			
Centre of buoyancy above baseline, in metres	KB	KB		KB	KB	VCB	$\overline{KB}$	KB
Transverse metacentre above baseline, in metres	KMT	T.KM	TKM	TKM	TKM	KM(T)	$\overline{KM}$	KM
Longitudinal metacentre above baseline, in metres	KML	L.KM		LKM	LKM	KM(L)	$\overline{KM}_L$	KM_L
Transverse metacentric height above centre of gravity, in metres, without allowing for free surface effect	GM	GM	GM	GM	GM	GM	$\overline{GM}$	GM
Correction for free surface effect, in metres	GG'	GGo	GGo		GGo			GG_V
Transverse metacentric height above centre of gravity, in metres, corrected for free surface effect, or fluid metacentric height	G'M, GMf	GoM	GoM	⦶GM	GoM	GMfluid	$\overline{GM}_F$	G_VM
Moment due to free surface effect		i	I	i			I_T	I, i
Righting arm, in metres, without correction for free surface effect	GZ	GZ	GZ	GZ	G'Z'	GZ	$\overline{GZ}$	GZ
Righting arm, in metres, corrected for free surface effect		GoZ	GoZ	GZ	GZ	GZ	$\overline{GZ}_F$	GZ
Flooding angle, in degrees	θf	θf			f	θf		
Heeling angle at maximum GZ, in degrees		θmax	θm	θ max	m			
Angle of vanishing stability		θv	θR	θr				
Propeller immersion		I/D	I/D		I/D			
Block coefficient	Cb	CB		Cb	CB		C_B	C_B
Prismatic coefficient	Cp	CP		Cp	CP		C_P	C_P

☆This ship used Imperial measurements

	Ship A	Ship B	Ship C	Ship D☆	Ship E	UK DTp	RINA	Derrett
Waterplane coefficient	Cwl	CW		Cw	CW		C_{WP}	C_w
Midships coefficient	Cm	C MID		Cm	CM		C_M	C_m
Area of waterplane, in square metres		WP		WA			A_W	A
Draft							T	d
Draft (forward), as read	df				d_{fo} dF			
Draft (forward), corrected	dF	dF	DF	d_{FP}	df			
Draft (midships), as read	dm				$d_{\oplus}$ dM			
Draft (midships), corrected	dM	$d\oplus$	DC	ds	$d_{\oplus}$			
Draft (aft), as read	da				d_{ao} dA			
Draft (aft), corrected	dA	dA	DA	d_{AP}	da			
Mean of forward and aft corrected drafts	dme	dM	dm		dm'			
Mean of mean drafts	dM'				dm			
Forward direction from midships, and trim by head	(+)	(–)	(–)	(–)	(–)			
Aft direction from midships, and trim by stern	(–)	(+)	(+)	(+)	(+)			

☆ This ship used Imperial measurements.

REGINA OLDENDORFF B270/7 Dalian -PRC MACS3 SHIPCOMPUTER....... BY SEACOS GMBH - GERMANY..	VOYAGE NUMBER......................:WHEAT 5/90 VOYAGE DESCRIPTION................:Bulk Wheat 24/5/90 NAME: kbg ˉRegina O' DATE: 02-13-92 TIME: 08:47:31 Three Rivers - Oran

ITEM........................ designation.................	WEIGHT.. ton.....	CENTRE OF GRAVITY....... LONGIT. m.f.AP.	VERTIC. m.a.BL.	TRANS. m.f.MS	FREE.... SURFACE. mt......	GRAIN... MOMENT.. mt......	CONTAINER 20ft/40ft units....	WEIGHT DISTRIB.. FROM... m.f.AP.	TO..... m.f.AP.
)Cargo									
GR.:G-HLD1U 6351M3 1.197M3/T	5305.8	157.170	8.359	0.000		1574.3		142.720	173.650
GR.:G-HLD2T 7865M3 1.246M3/T	6313.0	127.780	7.789	0.000		429.8		112.010	142.720
GR.:G-HLD3U 2858M3 1.246M3/T	2294.0	101.635	4.790	0.000		7165.4		90.430	112.010
GR.:G-HLD4T 8060M3 1.246M3/T	6469.0	75.080	7.790	0.000		439.3		58.890	90.430
GR.:G-HLD5U 6342M3 1.227M3/T	5169.0	45.421	8.103	0.000		1655.7		29.840	58.890
SUM....:Wheat	25550.8	101.531	7.702	0.000	0.0	11264.4		***.***	***.***
LOADING PACKAGE...:BUNK. 5/90	969.7	49.328	6.098	0.112	5453.7	0.0		***.***	***.***
LOADING PACKAGE...:WB 5/90	1450.0	78.698	1.779	0.000	306.6	0.0		***.***	***.***
DEADWEIGHT..................	27970.5	98.538	7.339	0.004	5760.3	11264.4	CONTAINER-TOTAL=		units
LIGHT-SHIP/STANDARD WEIGHT...	8051.0	79.458	10.119	0.000			SUM 20'-CONTAIN=		units
DISPLACEMENT................	36021.5	94.274	7.961	0.003			SUM 40'-CONTAIN=		units

DEADWEIGHT-MAX. TO SUM.FREEB.	28031.0	ton....
DEADWEIGHT-RESERVE TO SUM.FB.	60.5	ton....
DRAUGHT-MAX. TO SUMMER FREEB.	10.238	m.a.bok
DRAUGHT ACTUAL..............	10.222	m.a.bok
DRAUGHT RESERVE SUMMER-FREEB.	0.016	m.a.bok

```
RHO.SW......= Density of Sea-Water.........=   1.025 t/m3.
GM..........= Metacentric height...........=   1.534 metre
FS.COR......= Free surface correction......=   0.160 metre
GM.COR......= Metacentric height corrected..=  1.374 metre
GM.REQ......= Limit value of metacen.height.=  0.300 metre
GM.REQ IS VALID ONLY FOR... grain cargo
```

DRAUGHT CALCULATED metre above bok....	ON PER-PENDIC..	AT THE MARK....	
AFT...............	10.488		
MIDSHIP............	10.217		
FORWARD............	9.947		

TRIM.....= 0.169 degree (by stern) = 0.541 metre
HEELING due transverse mom.= 0.125 degree (stbd)

```
MˋWIND......= Moment of wind...............=  2500.0 mt...
A.MˋWI+TR...= Heeling due to wind+transv.mom=    3.1 degr.
```

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MˋGRAIN.....= Heeling moment of grain cargo.=11264.450 mt...
MˋGRAINmax..= Permissable moment of grain...=11749.980 mt...
A.MˋGRAIN...= Angle due to grain shifted....=  11.873 degr.
AR.GRAIN....= Area o.residual dyn.stability =   0.218 m*rad
```

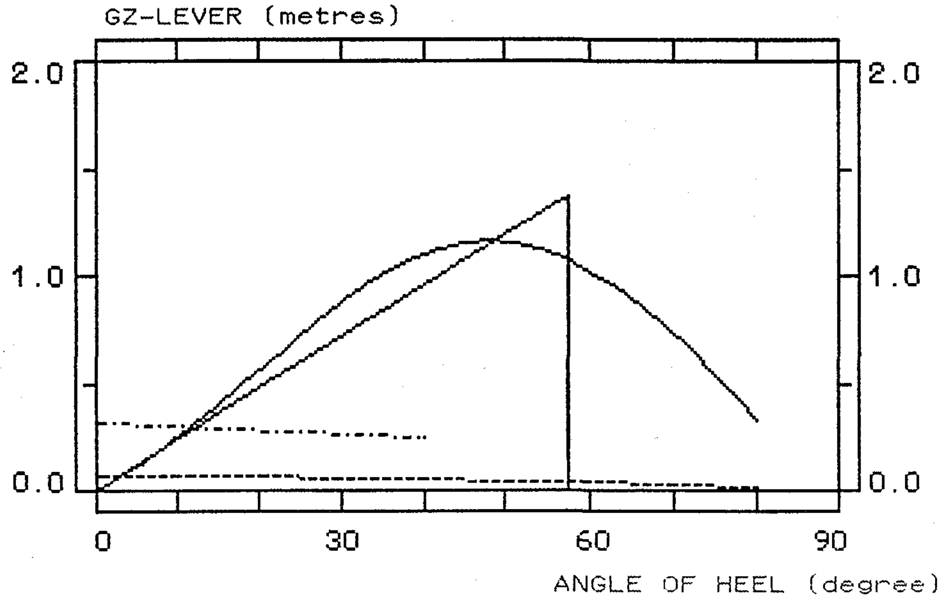
REGINA OLDENDORFF B270/7 Dalian -PRC MACS3 SHIPCOMPUTER....... BY SEACOS GMBH - GERMANY..	LOADING PACKAGE...................:BUNK. 5/90 LPAC DESCRIPTION..................:Bunker etc. NAME: kbg `Regina O.' 24/5/90 DATE: 02-13-92 TIME: 08:31:26 Three Rivers - Oran

ITEM........................ designation.................	WEIGHT.. ton.....	CENTRE OF GRAVITY....... LONGIT. m.f.AP.	VERTIC. m.a.BL.	TRANS. m.f.MS	FREE.... SURFACE. mt......	GRAIN... MOMENT.. mt......	CONTAINER 20ft/40ft units....	WEIGHT DISTRIB.. FROM... m.f.AP.	TO..... m.f.AP.
)Fuel Oil									
TANK:1FOT 0.9800t/m3 0.2%	1.0	127.369	0.002	0.000	185.7			112.010	142.720
TANK:2FOT 0.9800t/m3 0.3%	1.0	101.220	0.002	0.000	185.9			90.430	112.010
TANK:3FOT 0.9800t/m3 63.7%	305.0	74.660	0.474	0.000	2981.7			58.890	90.430
TANK:4FOT 0.9800t/m3 11.1%	35.2	47.240	0.082	0.000	1515.2			29.840	58.890
TANK:FOSTP 0.9800t/m3 34.2%	12.0	28.600	11.097	-7.891	25.5			27.350	29.840
TANK:FOSTS 0.9800t/m3 34.2%	12.0	28.600	11.097	7.891	25.5			27.350	29.840
TANK:FOSER 0.9800t/m3 61.9%	21.0	26.110	11.518	7.913	25.5			24.860	27.350
SUM....:Fuel Oil	387.2	66.884	1.694	0.429	4945.0	0.0		***.***	***.***
)Diesel Oil									
TANK:DOTP 0.8500t/m3 22.4%	18.1	24.833	0.408	-3.184	68.3			18.220	29.840
TANK:DOTS 0.8500t/m3 22.4%	18.1	24.833	0.408	3.184	68.3			18.220	29.840
TANK:DOSET 0.8500t/m3 87.9%	7.7	22.780	11.850	7.900	0.7			21.540	24.030
TANK:DOSER 0.8500t/m3 97.1%	8.5	22.780	11.979	6.300	0.7			21.540	24.030
SUM....:Diesel Oil	52.4	24.199	3.963	2.181	138.1	0.0		***.***	***.***
)Lubricating Oil									
TANK:LOS 0.9000t/m3 50.0%	7.3	24.030	0.412	0.000	3.0			21.540	26.520
TANK:SUMP 0.9000t/m3 4.6%	1.0	17.805	0.040	0.000	3.0			14.070	21.540
TANK:MELOS 0.9000t/m3 50.0%	12.8	15.480	8.069	-5.630	12.6			13.240	17.390
TANK:LOSET 0.9000t/m3 90.0%	18.8	18.670	8.538	-6.248	22.7			17.390	19.880
TANK:CYLOT 0.9000t/m3 80.0%	14.8	19.460	11.885	7.100	6.1			18.220	20.710
TANK:DGLOS 0.9000t/m3 91.1%	5.0	10.130	9.066	-5.031	4.4			8.260	11.580
TANK:DGLOL 0.9000t/m3 90.0%	2.7	12.470	7.982	-4.750	1.0			11.580	13.240
TANK:DGLOU 0.9000t/m3 81.3%	3.0	12.440	9.207	-5.396	4.1			11.580	13.240
SUM....:Lubricating Oil	65.3	17.614	8.214	-2.125	56.9	0.0		***.***	***.***
)Freshwater									
TANK:1FWTP 1.0000t/m3 48.0%	47.0	5.118	12.436	-4.404	137.5			2.630	7.430
TANK:2FWTP 1.0000t/m3 49.5%	31.0	-0.552	12.691	-5.089	24.3			-5.770	2.630
TANK:2FWTS 1.0000t/m3 49.5%	31.0	-0.552	12.691	5.089	24.3			-5.770	2.630
TANK:DWTS 1.0000t/m3 42.2%	40.0	5.125	12.345	4.339	118.5			2.630	7.430
TANK:CWT 1.0000t/m3 50.9%	11.0	6.414	2.184	0.000	1.1			4.430	7.430
SUM....:Freshwater	160.0	3.012	11.807	-0.209	305.6	0.0		***.***	***.***
)Sludge									
TANK:OWT 1.0000t/m3 18.5%	3.0	12.440	0.366	0.000	5.5			11.580	13.240
TANK:BILGE 1.0000t/m3 8.3%	2.0	9.708	0.173	0.000	2.5			7.430	11.580
SUM....:Sludge	5.0	11.347	0.289	0.000	8.1	0.0		***.***	***.***
)Stores etc.	250.0	60.000	8.500	0.000	0.0			-4.000	185.000
)Dunnage	49.7	80.000	10.000	0.000	0.0			30.000	180.000
TOTAL SUM....................	969.7	49.328	6.098	0.112	5453.7	0.0			

REGINA OLDENDORFF B270/7 Dalian -PRC MACS3 SHIPCOMPUTER....... BY SEACOS GMBH - GERMANY..	LOADING PACKAGE...................:WB 5/90 LPAC DESCRIPTION..................:Waterballast NAME: kbg `Regina O.' 24/5/90 DATE: 02-13-92 TIME: 08:31:55 Three Rivers - Oran

ITEM......................... designation.................	WEIGHT.. ton.....	CENTRE OF GRAVITY....... LONGIT. m.f.AP.	VERTIC. m.a.BL.	TRANS. m.f.MS	FREE.... SURFACE. mt......	GRAIN... MOMENT.. mt......	CONTAINER 20ft/40ft units....	WEIGHT DISTRIB.. FROM... m.f.AP.	TO..... m.f.AP.
TANK:FPT 1.0250t/m3 0.0%	0.0	175.465	0.000	0.000	0.0			173.650	186.250
)Doublebottom									
TANK:1WBTP 1.0250t/m3 0.0%	0.0	155.597	0.000	-2.900	0.0			142.720	173.650
TANK:1WBTS 1.0250t/m3 0.0%	0.0	155.597	0.000	2.900	0.0			142.720	173.650
TANK:2WBTP 1.0250t/m3 0.0%	0.0	127.286	0.000	-7.350	0.0			112.010	142.720
TANK:2WBTS 1.0250t/m3 0.0%	0.0	127.286	0.000	7.350	0.0			112.010	142.720
TANK:3WBTP 1.0250t/m3 82.2%	245.0	101.220	1.037	-8.754	18.1			90.430	112.010
TANK:3WBTS 1.0250t/m3 82.2%	245.0	101.220	1.037	8.754	18.1			90.430	112.010
TANK:4WBTP 1.0250t/m3 97.8%	430.0	74.546	1.398	-8.994	1.4			58.890	90.430
TANK:4WBTS 1.0250t/m3 97.8%	430.0	74.546	1.398	8.994	1.4			58.890	90.430
TANK:5WBTP 1.0250t/m3 0.0%	0.0	45.036	0.000	-6.400	0.0			29.840	58.890
TANK:5WBTS 1.0250t/m3 0.0%	0.0	45.036	0.000	-6.400	0.0			29.840	58.890
SUM....:Doublebottom	1350.0	84.228	1.267	0.000	39.0	0.0		***.***	***.***
)Topwingtanks									
TANK:1TSTP 1.0250t/m3 0.0%	0.0	142.171	9.510	-10.100	0.0			142.720	173.650
TANK:1TSTS 1.0250t/m3 0.0%	0.0	142.171	9.510	10.100	0.0			142.720	173.650
TANK:2TSTP 1.0250t/m3 0.0%	0.0	127.365	9.510	-11.000	0.0			112.010	142.720
TANK:2TSTS 1.0250t/m3 0.0%	0.0	127.365	9.510	11.000	0.0			112.010	142.720
TANK:3TSTP 1.0250t/m3 0.0%	0.0	101.220	9.510	-11.000	0.0			90.430	112.010
TANK:3TSTS 1.0250t/m3 0.0%	0.0	101.220	9.510	11.000	0.0			90.430	112.010
TANK:4TSTP 1.0250t/m3 0.0%	0.0	74.660	9.510	-11.000	0.0			58.890	90.430
TANK:4TSTS 1.0250t/m3 0.0%	0.0	74.660	9.510	11.000	0.0			58.890	90.430
TANK:5TSTP 1.0250t/m3 0.0%	0.0	57.470	9.510	-11.000	0.0			30.670	58.890
TANK:5TSTS 1.0250t/m3 0.0%	0.0	57.470	9.510	11.000	0.0			30.670	58.890
SUM....:Topwingtanks	0.0	0.000	0.000	0.000	0.0	0.0		***.***	***.***
TANK:APT 1.0250t/m3 37.2%	100.0	4.055	8.694	0.000	267.6			-4.570	7.430
TOTAL SUM....................	1450.0	78.698	1.779	0.000	306.6	0.0			

REGINA OLDENDORFF B270/7 Dalian -PRC MACS3 SHIPCOMPUTER....... BY SEACOS GMBH - GERMANY..	VOYAGE NUMBER......................:WHEAT 5/90 VOYAGE DESCRIPTION................:Bulk Wheat 24/5/90 NAME: kbg `Regina O' DATE: 02-13-92 TIME: 08:47:42 Three Rivers - Oran



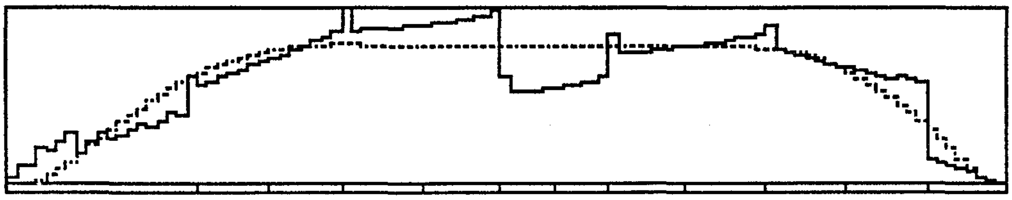
-- -- -- WIND + TRANSVERSE MOMENT
_ . _ . MOMENT OF GRAIN
.... TRANSVERSE MOMENT

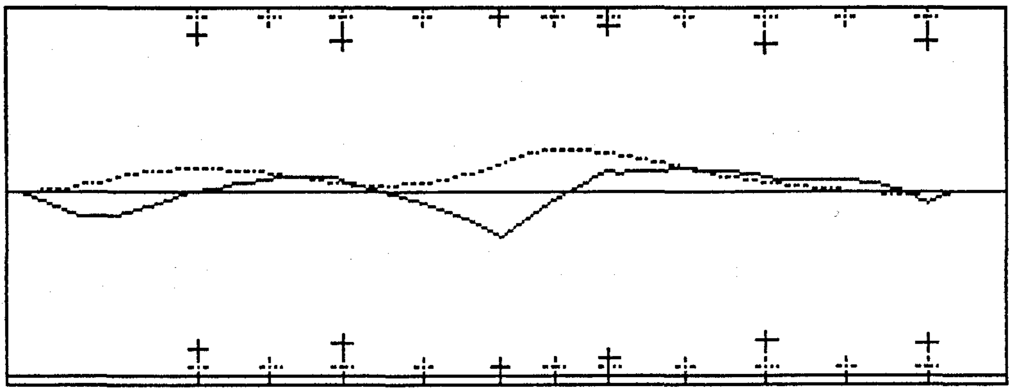
LEVERARM............... RESULTS................ metres.................	PHI = ANGLE OF HEEL (degree)								
	10.000	12.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000
KN-ORDINATE............	1.653	1.989	3.333	4.939	6.321	7.379	8.054	8.357	8.334
KG * SIN(PHI)..........	1.382	1.655	2.723	3.980	5.117	6.098	6.894	7.480	7.840
FREE SURFACE CORRECTION.	0.028	0.033	0.055	0.080	0.103	0.122	0.138	0.150	0.157
GZ-LEVER CORRECTED......	0.243	0.301	0.556	0.879	1.101	1.158	1.022	0.726	0.337
TRANSVERSE MOMENT ORDIN.	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.001	0.001
WIND+TRANSV.MOMENT ORDIN	0.071	0.071	0.068	0.063	0.055	0.047	0.036	0.025	0.013

ACTUAL VALUES......................................		
GM CORRECTED......................	1.374	metres
ANGLE DUE TO TRANSVERSE MOMENT.....	0.125	degrees
ANGLE DUE TO WIND+TRANSVERSE MOMENT	3.065	degrees
ANGLE DUE TO GRAIN SHIFTED.........	11.873	degrees
AREA OF RESIDUAL DYN. STABILITY....	0.218	m * rad
AREA UP TO 30 DEGREES.............	0.216	m * rad
AREA UP TO 40 DEGREES.............	0.390	m * rad
AREA BETWEEN 30 AND 40 DEGREES.....	0.175	m * rad
GZ LEVER AT 30 DEGREES............	0.879	metres
STATICAL STABILITY RANGE..........	80.000	degrees

LIMIT VALUES......................................		
GM CORRECTED......................	0.300	metres
ANGLE DUE TO TRANSVERSE MOMENT.....	3.000	degrees
ANGLE DUE TO WIND+TRANSVERSE MOMENT	17.773	degrees
ANGLE DUE TO GRAIN SHIFTED.........	12.000	degrees
AREA OF RESIDUAL DYN. STABILITY....	0.075	m * rad
AREA UP TO 30 DEGREES.............	0.055	m * rad
AREA UP TO 40 DEGREES.............	0.090	m * rad
AREA BETWEEN 30 AND 40 DEGREES.....	0.030	m * rad
GZ LEVER AT 30 DEGREES............	0.366	metres
STATICAL STABILITY RANGE..........	50.000	degrees

REGINA OLDENDORFF B270/7 Dalian -PRC MACS3 SHIPCOMPUTER....... BY SEACOS GMBH - GERMANY..	VOYAGE NUMBER......................:WHEAT 5/90 VOYAGE DESCRIPTION................:Bulk Wheat 24/5/90 NAME: kbg `Regina O' DATE: 02-13-92 TIME: 08:51:38 Three Rivers - Oran





LONGITUDINAL STRENGTH CALCULATION FOR HOMOGENEOUS LOADING

LONGITUDINAL. POSITION.....		.... SHEAR FORCES				.. BENDING MOMENTS ..			..STAT TORSION MOM ..		
				...REL...			...REL...			...REL...	
FRM. num.	DIST... m.f.ap.	EXISTING.. (kN)	CORRECTED. (kN)	SEA (%)	PORT (%)	EXISTING.. (kNm)	SEA (%)	PORT (%)	EXISTING.. (kNm)	SEA (%)	PORT (%)
40	30.670	-27	-27	0	0	106964	13	8			
57	44.780					85851	10	6			
74	58.890	-2688	-2448	7	6	40289	5	3			
93	74.660					42420	5	3			
112	90.430	9564	8155	21	19	132830	16	10			
125	101.220					197444	24	14			
138	112.010	-4658	-4486	12	11	181716	22	13			
156	126.950					112638	14	8			
175	142.720	-3161	-3333	10	8	44023	5	3			
197	158.250					5311	1	0			
219	173.650	2621	2621	8	7	-7544	1	1			

HYDROSTATIC TABLE

DRAFT (EXT) (M)	D (T)	V (M3)	LCB (M)	MTC (T-M)	LCF (M)	TKM (M)	LKM (M)	TPC (T)	KB (M)	AW (M2)	CB	CW	CP	CM	CUT (T/CM)	DRAFT (MLD) (M)
10.100	35551	34477	–3.567	482.70	1.454	9.474	253.68	38.50	5.216	3734	0.8124	0.887	0.817	0.993	0.306	10.082
10.110	35590	34515	–3.562	482.96	1.469	9.476	253.56	38.51	5.221	3735	0.8125	0.887	0.817	0.993	0.309	10.092
10.120	35628	34552	–3.557	483.22	1.483	9.477	253.43	38.52	5.226	3735	0.8126	0.887	0.817	0.993	0.312	10.102
10.130	35667	35689	–3.551	482.49	1.497	9.479	253.30	38.52	5.232	3736	0.8127	0.887	0.817	0.993	0.315	10.112
10.140	35795	34626	–3.546	483.75	1.511	9.480	253.17	38.53	5.237	3737	0.8127	0.887	0.818	0.993	0.318	10.122
10.150	35743	34664	–3.541	484.01	1.525	9.482	253.05	38.54	5.242	3737	0.8128	0.888	0.818	0.993	0.321	10.132
10.160	35782	34701	–3.536	484.27	1.539	9.484	252.92	38.55	5.247	3738	0.8129	0.888	0.818	0.993	0.324	10.142
10.170	35820	34738	–3.531	484.54	1.552	9.485	252.79	38.55	5.253	3739	0.8129	0.888	0.818	0.993	0.326	10.152
10.180	35859	34776	–3.525	484.80	1.566	9.487	252.67	38.56	5.258	3740	0.8130	0.888	0.818	0.993	0.329	10.162
10.190	35897	34813	–3.520	485.06	1.580	9.489	252.54	38.57	5.263	3740	0.8131	0.888	0.818	0.993	0.332	10.172
10.200	35936	34850	–3.515	485.33	1.593	9.490	252.42	38.58	5.268	3741	0.8132	0.888	0.818	0.993	0.335	10.182
10.210	35974	34888	–3.510	485.59	1.607	9.492	252.29	38.58	5.274	3742	0.8132	0.889	0.818	0.993	0.338	10.192
10.220	36013	34925	–3.505	485.85	1.621	9.494	252.17	38.59	5.279	3742	0.8133	0.889	0.818	0.993	0.341	10.202
10.230	36051	34962	–3.499	486.12	1.634	9.495	252.04	38.60	5.284	3743	0.8134	0.889	0.818	0.993	0.344	10.212
10.240	36090	35000	–3.494	486.38	1.648	9.497	251.92	38.61	5.290	3744	0.8135	0.889	0.818	0.993	0.347	10.222
10.250	36128	35037	–3.489	484.64	1.661	9.499	251.79	38.61	5.295	3745	0.8135	0.889	0.818	0.993	0.350	10.232
10.260	36167	35074	–3.484	486.91	1.674	9.500	251.67	38.62	5.300	3745	0.8136	0.889	0.818	0.993	0.353	10.242
10.270	36205	55112	–3.478	487.17	1.687	9.502	251.54	38.63	5.305	3746	0.8137	0.890	0.818	0.993	0.355	10.252
10.280	36244	35149	–3.473	487.43	1.701	9.504	251.42	38.63	5.311	3747	0.8138	0.890	0.818	0.993	0.358	10.262
10.290	36282	35186	–3.468	487.70	1.714	9.505	251.30	38.64	5.316	3747	0.8138	0.890	0.819	0.993	0.361	10.272
10.300	36321	35224	–3.463	487.96	1.727	9.507	251.17	38.65	5.321	3748	0.8139	0.890	0.819	0.993	0.364	10.282
10.310	36360	35261	–3.457	488.22	1.740	9.509	251.05	38.66	5.326	3749	0.8140	0.890	0.819	0.993	0.367	10.292
10.320	36398	35299	–3.452	488.49	1.753	9.511	250.93	38.66	5.332	3750	0.8140	0.890	0.819	0.993	0.370	10.302
10.330	36437	35336	–3.447	488.75	1.766	9.512	250.80	38.67	5.337	3750	0.8141	0.891	0.819	0.993	0.372	10.312
10.340	36475	35373	–3.441	489.01	1.779	9.514	250.68	38.68	5.342	3751	0.8142	0.891	0.819	0.993	0.375	10.322
10.350	36514	33411	–3.436	489.28	1.792	9.516	250.56	38.69	5.347	3752	0.8143	0.891	0.819	0.993	0.378	10.332
10.360	36552	35448	–3.431	489.54	1.805	9.518	250.44	38.69	5.353	3752	0.8143	0.891	0.819	0.993	0.381	10.342
10.370	36591	35486	–3.426	489.80	1.817	9.520	250.32	38.70	5.358	3753	0.8144	0.891	0.819	0.993	0.384	10.352
10.380	36630	35523	–3.420	490.07	1.830	9.521	250.19	38.71	5.363	3754	0.8145	0.891	0.819	0.993	0.386	10.362
10.390	36668	35561	–3.415	490.33	1.843	9.523	250.07	38.71	5.369	3755	0.8146	0.892	0.819	0.993	0.389	10.372

Extract of table from Regina Oldendorff *— for abbreviations see Appendix 10.1.*

Appendix 10.6

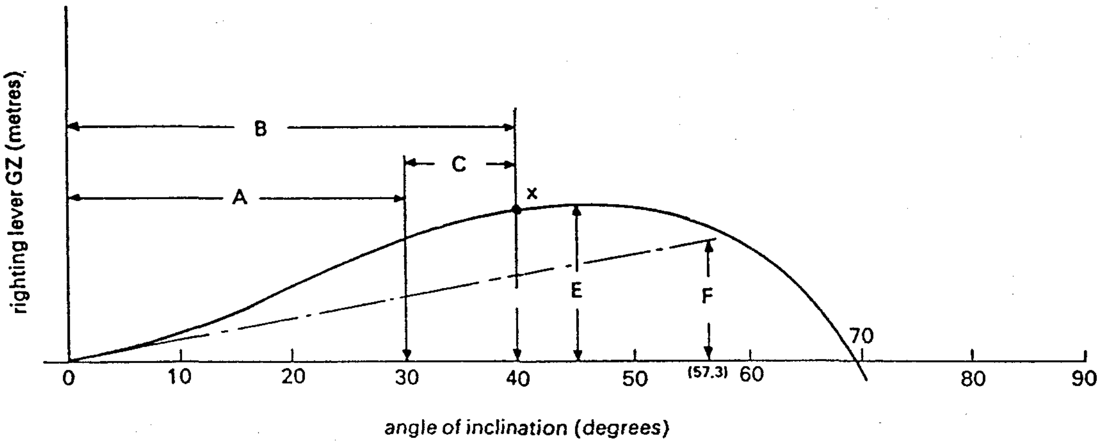
FREE SURFACE MOMENT OF INERTIA

NAME OF TANK	FRAME NO	MOMENT OF INERTIA (M^4)	SPECIFIC GRAVITY (T/M^3)	FREE SURFACE MOMENT (T-M)
No.1 F.O.T.	138-175	2962.5	0.98	2903.3
No.2 F.O.T.	112-138	2081.7	0.98	2040.1
No 3. F.O.T.	74-112	3042.6	0.98	2981.7
No 4. F.O.T.	39-74	1546.1	0.98	1515.2
D.O.T. (P. & S.)	25-39	123.4 x 2	0.85	209.8
No 1. F.W.T. (P)	4-12	1973	1.00	197.3
No 2. F.W.T. (P & S.)	–10-4	48.1 x 2	1.00	96.2
DRINKING W.T. (S')	4-12	182.7	1.00	182.7
F.P.T.	219-F	970	1.025	994.3
No 1. W.B.T. (P & S.)	175-219	2008.4 x 2	1.025	4117.2
No 2. W.B.T. (P & S)	138-175	605.3 x 2	1.025	1240.9
No 3. W.B.T. (P & S)	112-138	426.9 x 2	1.025	875.10
No 4. W.B.T. (P & S)	74-112	611.0 x 2	1.025	1252.6
No 5. W.B.T. (P & S)	39-74	547.7 x 2	1.025	1122.8
No 1. T.S.T. (P & S)	175-219	395.3 x 2	1.025	810.4
No 2. T.S.T. (P & S)	138-175	552.7 x 2	1.025	1133.0
No. 3 T.S.T. (P & S)	112-138	388.4 x 2	1.025	796.2
No. 4 T.S.T. (P & S)	74-112	567.7 x 2	1.025	1163.8
No. 5 T.S.T. (P & S)	40-74	508.9 x 2	1.025	1041.2
A.P.T.	–8-12	998.3	1.025	1023.3

SPECIAL NOTES REGARDING THE STABILITY AND LOADING OF THE SHIP

1. As this ship is required to comply with Schedule 4, Part I para. 2 of the 1968 Load Line Rules, it is most important to ensure that in any sailing condition the stability complies at least with the following minimum criteriaj-

Statical stability curve



A — area under curve up to 30 degrees to be not less than 0-055 metre-radian (10-34 feet degrees).
B - area under curve up to x degrees to be not less than 0-09 metre-radian (16-92 feet degrees).
C — area between 30 degrees and x degrees to be not less than 0-03 metre-radian (5-64 feet degrees).
x — 40 degrees or any lesser angle at which the lower edges of any openings in the hull, superstructure or deckhouses which lead below deck and cannot be closed weathertight, would be immersed.
E — maximum GZ to occur at angle not less than 30 degrees and to be at least 0-20 metre (0-66 foot) in height.
F - initial GM to be not less than 0-15 metre (0-49 foot). In ships with timber deck cargo 0-05 metre (0-16 foot) will be permitted. The volume of timber deck cargo may be included in the derivation of the cross curves.

STABILITY CALCULATIONS

THIS set of stability calculations has been prepared with the object of providing readers with full, step by step, guidance to all the routine calculations.

The rules and guidelines which apply to all the calculations are given below, and these are followed by a worked example of each calculation, with accompanying notes.

The form provided for each calculation has been specially designed for easy use. It avoids the use of abbreviations as much as possible, to avoid the confusion which comes from the great variety of abbreviations used. Where possible the form also shows the source of the information required for each entry (eg, 'Hydrostatic table', or 'L41 + L49'-meaning the sum of the numbers entered on lines 41 and 49).

Additional detailed explanations accompany each of the forms. They use line references (eg, L27 = line 27) for rapid identification of each item in the form, and reference letters (eg, [B]) to refer to points on the Curve of Statical Stability.

Rules and guidelines for calculations in these appendices

Units

The metric system is used throughout:

Length	Metres
Volume	Cubic metres
Weight	Metric tonnes
Density	Metric tonnes per cubic metre
Moment	Tonne metres
Free surface moment	Metres^4
Areas under curves	Metre radians

Arithmetic functions: symbols used Appendix 10.X1-10.X8
+ Add; - Subtract; * Multiply; / Divide.

Hierarchy of functions
Each formula has been arranged, as far as possible, so that the order in which it is read is the correct sequence for arithmetic calculation (ie, formulae have been presented to minimise the effect of hierarchy). Care should be taken, however, particularly if using a sequential calculator. (A sequential calculator shows that 1+2*3=9. If correct mathematical sequence is followed 1+2*3=7.)

Arithmetic signs
Formulae have been composed to give appropriate signs, with notes where the convention of the vessel may differ. The sign must be transferred with the element of the formula, (x + -y becomes x - y.)

Conventions used
Distance of longitudinal centres of gravity, flotation and buoyancy must be measured from the midpoint.
Sign is negative if centre is forward of the midpoint.
Trim by the head and change of trim forward are negative.

Alternative conventions
The stability and loading manuals of some ships are compiled using conventions which are different from those used in the calculations and forms provided in this book.

Officers on such ships who wish to use the calculations shown in this book must make the following amendments to values taken from the ship's stability and loading manual.

Longitudinal distances. When distance of longitudinal centres are given from the aft perpendicular they must be amended to obtain the distance of the longitudinal centre from the midpoint.

Longitudinal centre from midpoint = LBP/2- LCAP
where: LBP = Length between perpendiculars
LCAP = Longitudinal centre from aft perpendicular

Signs of distances. When the sign of a longitudinal distance is negative when measured aft from the midpoint the sign must be reversed (- becomes +, + becomes -) before it is used in the calculation.

Sign of trim. When trim by the stern and change of trim aft are negative the sign must be reversed before the values are used in calculation.

Worksheets
Items to be entered in the forms by hand are shown in italics.

1	**Displacement Calculation**		
2	*REGINA OLDENDORFF. Before Loading.*		
3	Item	Value	Source
4	Observations at Draft Survey		
5	Forward Draft Port	*5.06*	Observed
6	Forward Draft Starboard	*5.04*	Observed
7	Midships Draft Port	*6.08*	Observed
8	Midships Draft Starboard	*5.68*	Observed
9	Aft Draft Port	*6.96*	Observed
10	Aft Draft Starboard	*6.92*	Observed
11	Density	*1.013*	Observed
12	Drafts at Marks		
13	Forward	*5.050*	(L5+L6)/2
14	Midships	*5.880*	(L7+L8)/2
15	Aft	*6.940*	(L9+L10)/2
16	Trim between Marks	*1.890*	L15-L13
17	Length Between Marks	*177.62*	Ship's Particulars
18	Distances from Marks to Perpendiculars		
19	Negative if Perpendicular forward of Mark		
20	Forward	*-0.35*	Ship's Particulars
21	Midships	*0.00*	Ship's Particulars
22	Aft	*5.03*	Ship's Particulars
23	Corrections to drafts at Marks		
24	Forward	*-0.004*	L16/L17*L20
25	Midships	*0.000*	L16/L17*L21
26	Aft	*0.054*	L16/L17*L22
27	Drafts at Perpendiculars		
28	Forward	*5.046*	L13+L24
29	Midhips	*5.880*	L14+L25
30	Aft	*6.994*	L15+L26
31	Trim between Perpendiculars	*1.948*	L30-L28
32	Mean of Means	*5.915*	(L29*6+L28+L30)/8
33	Displacement from Table	*19987.00*	Hydrostatic Table
34	Length Between Perpendiculars	*183.00*	Ship's Particulars
35	Distance from Midpoint to Longitudinal Centre of Flotation.		
36	Negative if Longitudinal Centre of Flotation forward of Midpoint.		
37	Longitudinal Centre of Flotation	*-4.161*	Hydrostatic Table
38	Tonnes per Centimetre Immersion	*36.10*	Hydrostatic Table
39	First Trim Correction	*-159.90*	L31/L34*L37*L38*100
40	Mean of Means + 0.5	*6.415*	L32+0.5
41	Mean of Means - 0.5	*5.415*	L32-0.5
42	Moment to Change Trim One Centimetre		
43	at Mean of Means + 0.5	*409.48*	Hydrostatic Table
44	at Mean of Means - 0.5	*396.41*	Hydrostatic Table
45	Difference of MCTC	*13.07*	L43-L44
46	Second Trim Correction	*13.55*	L31*L31/L34*L45*50
47	Difference between Midships drafts	*0.40*	L7-L8
48	Tonnes per Centimetre Immersion		
49	at Midships Draft Port	*36.17*	Hydrostatic Table
50	at Midships Draft Starboard	*35.99*	Hydrostatic Table
51	Difference between TPC	*0.18*	L49-L50
52	Heel Correction	*0.43*	L47*L51*6
53	Displacement Corrected	*19841.08*	L33+L39+L46+L52
54	Density of Hydrostatic Table	*1.025*	Hydrostatic Table
55	Displacement	*19608.79*	L53*L11/L54

Displacement Calculation.

```
L1  Identity of Worksheet.
L2  Identity of vessel and survey.
L3  Titles of Columns.
L4/
L11 Values observed at survey.
L12/
L15 Drafts at Marks = (DP+DS)/2
       Where:- DP = Draft at Port Mark
               DS = Draft at Starboard Mark
L16 Trim between Marks. Negative if Forward Draft is greater than Aft
    Draft.
    Trim = DA-DF
       Where:- DA = Draft Aft
               DF = Draft Forward,
L17 Length Between Forward and Aft Draft Marks. Extract from Ship's
    Stability and Loading Manual. May be calculated from Length Between
    Perpendiculars and Distances from Draft Marks to Perpendiculars.
L18/
L22 Distances from Draft Marks to Perpendiculars. Extract from Ship's
    Stability and Loading Manual. Negative if Perpendicular is forward
    of Mark.
L23/
L26 Corrections to be applied to Drafts at Marks to find Drafts at
    Perpendiculars.
       Correction = TM/LBM*MtP
          Where:- TM  = Trim between Marks
                  LBM = Length Between Marks
                  MtP = Distance from Mark to Perpendicular
L27/
L30 Drafts at Perpendiculars = DM+C
       Where:- DM = Draft at Mark
               C  = Correction
L31 Trim between Perpendiculars, as Trim between Marks.
L32 Mean of Mean Drafts = (M*6+F+A)/8
       Where:- M = Draft at Midships Perpendicular
               F = Draft at Forward Perpendicular
               A = Draft at Aft Perpendicular
L33 Displacement from Table. Extract from Hydrostatic Table. Value
    corresponding to Mean of Mean Drafts.
L34 Length Between Perpendiculars. Extract from Ship's Stability and
    Loading Manual.
L37 Longitudinal Centre of Flotation. Extract from Hydrostatic Table.
    Value corresponding to Mean of Mean Drafts. Negative if
    Longitudinal Centre of Flotation is forward of Midpoint.
    Distance from Midpoint of Length Between Perpendiculars is
    required. Some tables present distances from Aft Perpendicular; if
    so calculate difference between LCF and LBP/2 and allocate sign.
L38 Tonnes per Centimetre Immersion. Extract from Hydrostatic Table.
    Value corresponding to Mean of Mean Drafts.
L39 First Trim Correction = TP/LBP*LCF*TPC*100
       Where:- TP  = Trim between Perpendiculars
               LBP = Length Between Perpendiculars
               LCF = Longitudinal Centre of Flotation
               TPC = Tonnes per Centimetre Immersion
L40 Draft 0.5 metres greater than Mean of Mean Drafts.
L41 Draft 0.5 metres less than Mean of Mean Drafts.
L42/
L44 Moment to Change Trim One Centimetre. Extract from Hydrostatic
    Table. Values corresponding to Drafts 0.5 metres greater and less
    than Mean of Mean Drafts.
```

L45 Rate of change of MCTC per metre. Difference between above values of MCTC.

L46 Second Trim Correction = TP*TP/LBP*DMCTC*50
Where:- TP = Trim Between Perpendiculars
LBP = Length Between Perpendiculars
DMCTC = Rate of Change of MCTC per Metre

L47 Difference between Midships Drafts = MDP-MDS
Where:- MDP = Midships Draft Port
MDS = Midships Draft Starboard

L48/
L50 Tonnes Per Centimetre Immersion. Extract from Hydrostatic Table. Values corresponding to Midships Drafts Port and Starboard.

L51 Difference between TPC at Midships Drafts = TPCP-TPCS
Where:- TPCP = Tonnes Per Centimetre Immersion at Midships Draft Port
TPCS = Tonnes Per Centimetre Immersion at Midships Draft Starboard

L52 Heel Correction = DMD*DTPC*6
Where:- DMD = Difference between Midships Drafts
DTPC = Difference between Tonnes Per Centimetre Immersion at Midships Drafts

L53 Displacement Corrected = DT+FTC+STC+HC
Where:- DT = Displacement from Table
FTC = First Trim Correction
STC = Second Trim Correction
HC = Heel Correction

L54 Density used in compilation of Hydrostatic Table. Extract from Hydrostatic Table. If not stated, assume 1.025 MT/CM.

L55 Displacement = DC*D/DHT
Where:- DC = Displacement Corrected
D = Density of water
DHT = Density of Hydrostatic Table

Note. This method is the same in principle as that used in the United Nations Economic and Social Council Code of Uniform Standards and Procedures for the Performance of Draught Surveys of Coal Cargoes[60], with the addition of the Heel Correction.

1 **Trim and Initial Stability**
2 *REGINA OLDENDORFF. Summer Marks.*
3 LCG, LCB and LCF from Midpoint.
4 Negative if Centre forward of Midpoint.

5	Identity	Weight	Longitudinal	Longitudinal	Vertical	Vertical	Free Surface
6			Centre of	Moment	Centre of	Moment	or Volumetric
7			Gravity		Gravity		Heeling Momnt
8		W	LCG	W*LCG	VCG	W*VCG	
9	*Fuel Oil*						
10	*No 1*	*452*	*-35.86*	*-16209*	*0.74*	*334*	*2903*
11	*No 2*	*318*	*-9.72*	*-3091*	*0.74*	*235*	*2040*
12	*No 3*	*464*	*16.84*	*7814*	*0.74*	*343*	*2982*
13	*No 4*	*309*	*44.26*	*13676*	*0.74*	*229*	*1515*
14	*Service*	*25*	*65.39*	*1635*	*12.05*	*301*	
15	*Settling*	*53*	*62.90*	*3334*	*12.04*	*638*	
16							
17	*Diesel Oil*	*135*	*66.48*	*8975*	*2.42*	*327*	*210*
18	*Lub Oil*	*71*	*74.00*	*5254*	*5.71*	*405*	
19	*Water*	*238*	*88.60*	*21087*	*13.26*	*3156*	*476*
20	*Constant*	*105*	*66.40*	*6972*	*10.17*	*1068*	
21							
22	*Cargo Holds*						
23	*No 1*	*5478*	*-65.67*	*-359740*	*8.36*	*45796*	
24	*No 2*	*6293*	*-36.28*	*-228310*	*7.79*	*49022*	
25	*No 3*	*2283*	*-10.13*	*-23127*	*4.78*	*10913*	
26	*No 4*	*6448*	*16.42*	*105876*	*7.79*	*50230*	
27	*No 5*	*5359*	*46.08*	*246943*	*8.11*	*43461*	
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38	Deadweight	*28031*					
39	Light Ship	*8051*	*12.04*	*96950*	*10.12*	*81468*	
40	Displacement	*36082*		*-111962*		*287928*	*10126*

41	Draft at Centre of Flotation	*10.238*	Hydrostatic Table
42	Longitudinal Centre of Gravity	*-3.103*	L40 LM/W
43	Longitudinal Centre of Buoyancy	*-3.495*	Hydrostatic Table
44	Moment to Change Trim One Centimetre	*486.33*	Hydrostatic Table
45	Trim	*0.291*	(L42-L43)*L40W/L44/100
46	Length Between Perpendiculars	*183.00*	Ship's Particulars
47	Longitudinal Centre of Flotation	*1.645*	Hydrostatic Table
48	Difference of Draft Forward	*-0.148*	-(L46/2+L47)*L45/L46
49	Difference of Draft Aft	*0.143*	(L46/2-L47)*L45/L46
50	Draft Forward	*10.090*	L41+L48
51	Draft Aft	*10.381*	L41+L49
52	Transverse Metacentre	*9.497*	Hydrostatic Table
53	Vertical Centre of Gravity	*7.980*	L40 VM/W
54	Metacentric Height	*1.517*	L52-L53
55	Free Surface Effect	*0.281*	L40 FSM/W
56	Fluid Metacentric Height	*1.236*	L54-L55
57	Permissible Grain Heeling Moment		Hydrostatic Table
58	Volumetric Heeling Moment		Total VHM
59	Density of Grain Cargo		MT/CM
60	Grain Heeling Moment		L58*L59 <L57

Trim and Initial Stability Calculation

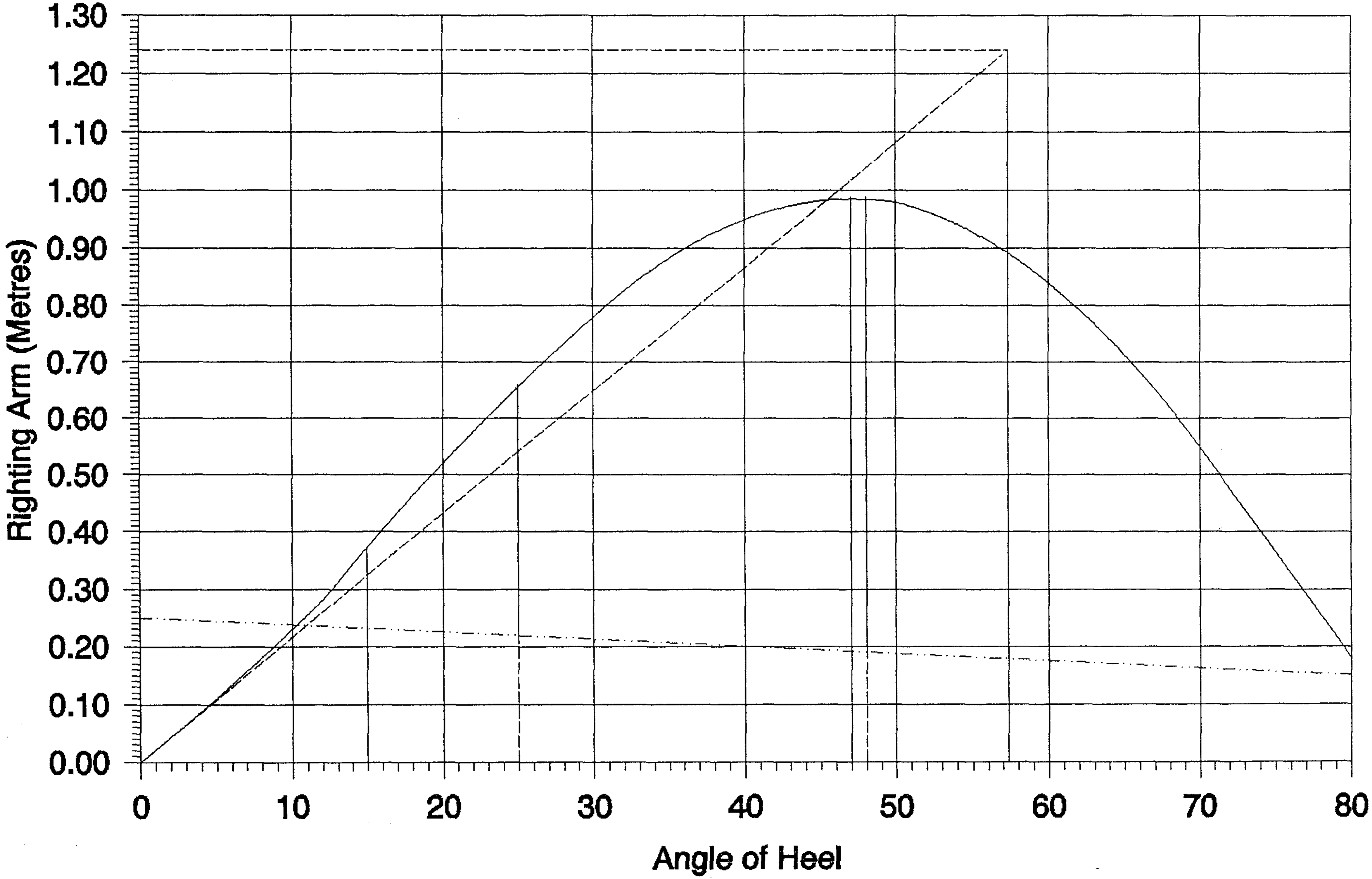
L1 Identity of worksheet
L2 Description of vessel and condition
L3/
L4 Note regarding Longitudinal Centres
L5/
L8 Titles of columns, abbreviations and formulae.
  Identity of Item
  Weight = V*D
    Where:- V = Volume
        D = Density
    Value can be otherwise derived, or estimated.
  Longitudinal Centre of Gravity, from Midpoint, negative if LCG forward of Midpoint. Extract from Ship's Stability and Loading Manual. Value will vary with the position of the contents of the space.
  Longitudinal Moment = W*LCG
    Where:- W = Weight
        LCG = Longitudinal Centre of Gravity
  Vertical Centre of Gravity. Extract from Ship's Stability and Loading Manual. Value will vary with the height of the contents of the space.
  Vertical Moment = W*VCG
    Where:- W = Weight
        VCG = Vertical Centre of Gravity
  Free Surface or Volumetric Heeling Moment. Extract from Ship's Stability and Loading Manual. Value will vary with the height and density of the contents of the space.
L9/
L37 Details of individual items. When Grain is carried the Volumetric Heeling Moments must be extracted from the Ship's Stability and Loading Manual with care, using values for full or part filled holds, for trimmed or untrimmed ends, and for volumetric or cargo centres as appropriate. The total Free Surface Moment must be calculated separately from the total Volumetric Heeling Moment.
L38 Deadweight. The total of the above Weights.
L39 Light Ship details. Extract from Ship's Stability and Loading Manual.
L40 Displacement details. Weight; Longitudinal, Vertical and Free Surface Moments are the totals of the values entered above. When grain is carried care must be taken not to include the Volumetric Heeling Moments in the Free Surface Moment total.
L41 Draft at Centre of Flotation. Extract from Hydrostatic Table as Draft Extreme. Value corresponding to Displacement.
L42 Longitudinal Centre of Gravity = LM/W
  Where:- LM = Longitudinal Moment, see L40
      W = Displacement, see L40
L43 Longitudinal Centre of Buoyancy, from Midpoint, negative if LCB forward of Midpoint. Extract from Hydrostatic Table. Value corresponding to Displacement.
L44 Moment to Change Trim One Centimetre. Extract from Hydrostatic Table. Value corresponding to Displacement.
L45 Trim = (LCG-LCB)*W/MCTC/100
  Where:- LCG = Longitudinal Centre of Gravity, see L42
      LCB = Longitudinal Centre of Buoyancy, see L43
      W = Displacement, see L40
      MCTC = Moment to Change Trim One Centimetre, see L44
L46 Length Between Perpendiculars. Extract from Ship's Stability and Loading Manual.
L47 Longitudinal Centre of Flotation, from Midpoint, negative if LCF forward of Midpoint. Extract from Hydrostatic Table. Value corresponding to Displacement.

L48 Difference of Draft Forward = -(LBP/2+LCF)*T/LBP
Where:- LBP = Length Between Perpendiculars, see L46
LCF = Longitudinal Centre of Flotation, see L47
T = Trim, see L45
L49 Difference of Draft Aft = (LBP/2-LCF)*T/LBP
Where:- LBP = Length Between Perpendiculars, see L46
LCF = Longitudinal Centre of Flotation, see L47
T = Trim, see L45
L50 Draft Forward = DCF+dDF
Where:- DCF = Draft at Centre of Flotation, see L41
dDF = Difference of Draft Forward, see L48
L51 Draft Aft = DCF+dDA
Where:- DCF = Draft at Centre of Flotation, see L41
dDA = Difference of Draft Aft, see L49
L52 Transverse Metacentre. Extract from Hydrostatic Table (TKM). Value corresponding to Displacement.
L53 Vertical Centre of Gravity = VM/W
Where:- VM = Vertical Moment, see L40
W = Displacement, see L40
L54 Metacentric Height = TKM-KG
Where:- TKM = Transverse Metacentre, see L52
KG = Vertical Centre of Gravity, see L53
L55 Free Surface Effect = FSM/W
Where:- FSM = Free Surface Moment, see L40. Must not include Volumetric Heeling Moments.
W = Displacement, see L40
L56 Fluid Metacentric Height = GM-FSE
Where:- GM = Metacentric Height, see L54
FSE = Free Surface Effect, see L55
For grain cargo this value must be greater than the minimum value (normally 0.30) shown in the Ship's Stability and Loading Manual for the worst condition expected during the voyage, before the vessel can put to sea.
L57 Permissible Grain Heeling Moment. Extract from Hydrostatic Table. Value corresponding to Deadweight and KG.
L58 Volumetric Heeling Moment. Total of Volumetric Heeling Moments of compartments containing grain, calculated separately from Free Surface Moments.
L59 Density of Grain Cargo. MT/CM. MT is weight of entire cargo in Metric Tonnes. CM is volume occupied by cargo in Cubic Metres. Before loading the figure for Density should be the best available estimate. After loading the figure used should be calculated from the actual tonnage, and volume used. When hold ends are untrimmed the reduced hold capacity, read from the Ship's Stability and Loading Manual, should be used. When a space is part filled the actual volume occupied, as calculated from the measured ullage, should be used.
L60 Grain Heeling Moment = VHM*D
Where:- VHM = Volumetric Heeling Moment, see L58.
D = Density of Cargo, see L59.
Once it has been calculated that the Metacentric Height is adequate this is the only additional check which is required. The loading is acceptable provided that L59<L57. If this condition is not satisfied the ship's stability is inadequate and the loading must be replanned or, if the cargo is already loaded, steps must be taken to improve the vessel's stability.

1	**Statical and Dynamical Stability**					
2	*REGINA OLDENDORFF. Summer Marks. Grain.*					
3	Displacement				*36082*	
4	Fluid Metacentric Height				*1.24*	
5	Vertical Centre of Gravity				*7.98*	
6	Free Surface Effect				*0.28*	
7	Fluid Vertical Centre of Gravity L5+L6				*8.26*	
8	Assumed Vertical Centre of Gravity				*7.00*	
9	Difference between Vertical Centres of Gravity L8-L7				*-1.26*	
10	Righting Arm Curve					
11	Angle	Sine	Correction	Assumed	Righting	
12	of		L9*Sine	Righting	Arm	
13	Heel			Arm	ARA+C	
14	*0.00*	*0.000*	*0.00*	*0.00*	*0.00*	
15	*10.00*	*0.174*	*-0.22*	*0.45*	*0.23*	
16	*12.00*	*0.208*	*-0.26*	*0.54*	*0.28*	
17	*20.00*	*0.342*	*-0.43*	*0.95*	*0.52*	
18	*30.00*	*0.500*	*-0.63*	*1.41*	*0.78*	
19	*40.00*	*0.643*	*-0.81*	*1.76*	*0.95*	
20	*50.00*	*0.766*	*-0.97*	*1.95*	*0.98*	
21	*60.00*	*0.866*	*-1.09*	*1.93*	*0.84*	
22	*70.00*	*0.940*	*-1.18*	*1.73*	*0.55*	
23	*80.00*	*0.985*	*-1.24*	*1.42*	*0.18*	
24	**IMO International Convention on Load Lines 1966**					Required
25	Righting Arm at 0° Heel [A]				*0.00*	Values *
26	Righting Arm at 15° Heel [DE]				*0.37*	
27	Righting Arm at 30° Heel [FG]				*0.78*	
28	Area to 30° (L26*4+L25+L27)*15/3/57.3 [AFG]				*0.197*	=>0.055
29	Angle of Flooding				*44*	
30	θF, Angle of Flooding L29, or 40°, whichever less.				*40*	
31	Half θF L30/2				*20*	
32	Righting Arm at 0° Heel L25 [A]				*0.00*	
33	Righting Arm at Half θF° Heel L31 [HI]				*0.52*	
34	Righting Arm at θF° Heel L30 [JK]				*0.95*	
35	Area to θF (L33*4+L32+L34)*L31/3/57.3 [AJK]				*0.353*	=>0.090
36	Area 30° to θF L35-L28 [GFJK]				*0.156*	=>0.030
37	Maximum Righting Arm [LM]				*0.99*	=>0.20
38	Angle of Maximum Righting Arm [M]				*47*	=>30°
39	Initial Fluid Metacentric Height L4 [BC]				*1.24*	=>0.15
40	**IMO International Grain Code 1991**					
41	Heeling Arm Curve					
42	Volumetric Heeling Moment of grain				*11100*	
43	Density of Cargo				*0.80*	
44	Heeling Arm at 0° L42/L3*L43 [AN]				*0.25*	
45	Heeling Arm at 40° L44*0.8 [OK]				*0.20*	
46	Angle of Heel due to Grain Shift, [Q], at					
47	Intersection of Righting and Heeling Arm curves [P]				*10*	<=12
48	Angle where difference between					
49	Righting Arm and Heeling Arm curves is maximum [R]				*48*	
50	Limit of Residual Dynamic Stability,					
51	Least value of L29, L49 and 40°				*40*	
52	Midpoint of range (L47+L51)/2 [S]				*25*	
53	Ordinate L51-L52				*15*	
54	Differences between Righting and Heeling Arms					
55	At Angle of Heel due to Grain Shift L47 [P]				*0.00*	
56	At Midpoint of range L52 [TU]				*0.44*	
57	At Limit of Residual Dynamic Stability L51 [JO]				*0.75*	
58	Residual Dynamic Stability (L56*4+L55+L57)*L53/3/57.3 [PJO]				*0.219*	=>0.075
59	Initial Fluid Metacentric Height L4 [BC]				*1.24*	=>0.30
60	**IMO Code of Safe Practice for Ships <100m Carrying Timber Deck Cargoes**					
61	Area to θF L35				*0.353*	=>0.08
62	Maximum Righting Arm L37				*0.99*	=>0.25
63	Initial Fluid Metacentric Height in Departure Condition L4				*1.24*	=>0.10
64	Fluid Metacentric Height to be positive throughout voyage.					
65	* The Ship's Stability and Loading Manual should be checked for					
66	specific requirements, see Note in explanation.					

Appendix 10.X3 (2)

Curve of Statical Stability
REGINA OLDENDORFF
Summer Marks. Grain.



Statical and Dynamical Stability Calculation.

L1 Identity of worksheet.
L2 Identity of vessel and condition.
L3 Displacement, from Initial Stability calculation.
L4 Fluid Metacentric Height, from Initial Stability calculation.
L5 Vertical Centre of Gravity, from Initial Stability calculation.
L6 Free Surface Effect, from Initial Stability calculation.
L7 Fluid Vertical Centre of Gravity = VCG+FSE
    Where:- VCG = Vertical Centre of Gravity, see L5.
            FSE = Free Surface Effect, see L6
L8 Vertical Centre of Gravity assumed when Cross Curves of Stability were drawn. This may be zero, in which case the curves are known as KN Curves.
L9 Difference between Vertical Centres of Gravity = AVCG-VCG
    Where:- AVCG = Assumed Vertical Centre of Gravity, see L8
            VCG = Vertical Centre of Gravity, see L7
    Negative if Vertical Centre of Gravity higher than Assumed Vertical Centre of Gravity.
L10/
L23 Calculation of data for Righting Arm Curve.
    Angle of Heel. Values of lines given on Cross Curves of Stability.
    Sine. Natural Sine of Angle of Heel.
    Correction = DVCG*Sin H
        Where:- DVCG = Difference between Vertical Centres of Gravity, see L9
                Sin H = Natural Sine of Angle of Heel.
    Assumed Righting Arm. Extract from Cross Curves of Stability the values which correspond to the Displacement.
    Righting Arm = ARA+C
        Where:- ARA = Assumed Righting Arm
                C = Correction
    The above values are used to draw the Curve of Statical Stability, which is a graph of Righting Arm against Angle of Heel. The initial gradient of this curve is given by a straight line from the origin, [A], to a point, [B], given by an angle of 57.3° and the value of the Fluid Metacentric Height, see L4.
L24 **IMO International Convention on Load Lines 1966.**
    The calculated values must be checked against the required values provided in the Ship's Stability and Loading Manual in compliance with the above.
L25 Righting Arm at 0° Heel, from Curve of Statical Stability, [A].
L26 Righting Arm at 15° Heel, from Curve of Statical Stability, [DE].
L27 Righting Arm at 30° Heel, from Curve of Statical Stability, [FG].
L28 Area to 30°, [AFG] = (RA15*4+RA0+RA30)*15/3/57.3
    Where:- RA15 = Righting Arm at 15° Heel, see L26.
            RA0 = Righting Arm at 0° Heel, see L25.
            RA30 = Righting Arm at 30° Heel, see L27.
    To be not less than 0.055
L29 Angle of Flooding. Extract from Flooding Angle Curve in the Ship's Stability and Loading Manual the value which corresponds to the Displacement.
L30 θF Angle of Flooding, see L29, or 40°, whichever is less.
L31 Half θF = θF/2, see L30
L32 Righting Arm at 0° Heel, from Curve of Statical Stability, [A].
L33 Righting Arm at Half θF° Heel, see L31, from Curve of Statical Stability, [HI].
L34 Righting Arm at θF° Heel, see L30, from Curve of Statical Stability, [JK].

L35 Area to ΘF, [AJK] = (RAHΘF*4+RA0+RAΘF)*HΘF/3/57.3
Where:- RAHΘF = Righting Arm at Half ΘF, see L33
RA0 = Righting Arm at 0°, see L32
RAΘF = Righting Arm at ΘF, see L34
HΘF = Half ΘF, see L31
To be not less than 0.090
L36 Area 30° to ΘF, [GFJK] = AΘF-A30
Where:- AΘF = Area to ΘF, see L35
A30 = Area to 30°, see L28
To be not less than 0.030
L37 Maximum Righting Arm, from Curve of Statical Stability, [LM].
To be not less than 0.20.
L38 Angle where Righting Arm has maximum value, from Curve of Statical Stability, [M]. To be not less than 30°.
L39 Initial Fluid Metacentric Height, from Initial Stability calculation, see L4. To be not less than 0.15.
L40 **IMO International Grain Code 1991.**
The calculated values must be checked against the required values if the vessel is loaded with grain.
L41 Heeling Arm Curve. A straight line drawn from the value of the Heeling Arm at 0°, L44 [AN], to the value of the Heeling Arm at 40°, L45 [OK], and projected if required.
L42 Volumetric Heeling Moment of grain. Extract from Ship's Stability and Loading Manual. Value will vary with height of hold contents, degree of trimming, method of measuring hold contents and type of data provided.
L43 Density of Cargo in Metric Tonnes per Cubic Metre, from loading orders, loading port authorities or other source. The figure given may be a Stowage Factor, to be converted as follows:-
Density = 1/SF
Where SF = Stowage Factor in Cubic Metres per Metric Tonne.
L44 Heeling Arm at 0°, [AN] = VHM/W*D
Where:- VHM = Volumetric Heeling Moment, see L42.
W = Displacement, see L3.
D = Density of Cargo, see L43.
L45 Heeling Arm at 40°, [OK] = HA0*0.8
Where:- HA0 = Heeling Arm at 0°, see L44.
L46/
L47 Angle of Heel due to Grain Shift [Q]. The angle at which the Righting and Heeling Arm Curves intersect [P], from Curve of Statical Stability. To be not more than 12°.
L48/
L49 Angle where difference between Righting and Heeling Arm Curves is maximum. From Curve of Statical Stability, [R].
L50/
L51 Limit of Residual Dynamic Stability, whichever is least of:-
Angle of Flooding, see L29,
Angle of Maximum Difference between Righting and Heeling Arm Curves, see L49, and
40°.
L52 Midpoint of range, [S] = (AH+LRDS)/2
Where:- AH = Angle of Heel due to Grain Shift, see L47.
LRDS = Limit of Residual Dynamic Stability, see L51.
L53 Ordinate = M-AH
Where:- M = Midpoint of range, see L52.
AH = Angle of Heel due to Grain Shift, see L47.
L54 Differences between Heeling and Righting Arms at:-
L55 Angle of Heel due to Grain Shift, from Curve of Statical Stability, [P].
L56 Midpoint of range, from Curve of Statical Stability, [TU].
L57 Limit of Residual Dynamic Stability, from Curve of Statical Stability, [JO].

L58 Residual Dynamic Stability [PJO] = (DM*4+DAH+DL)*O/3/57.3
Where:- DM = Difference at Midpoint of range, see L56.
DAH = Difference at Angle of Heel, see L55.
DL = Difference at Limit, see L57.
O = Ordinate, see L53.
To be not less than 0.075.

L59 Initial Fluid Metacentric Height, [BC], see L4.
To be not less than 0.30.

L60 **IMO Code of Safe Practice for Ships <100m Carrying Timber Deck Cargoes.**
When the ship is less than 100 metres in length and loaded with a deck cargo of timber in accordance with the Code the appropriate values must be checked against the requirements of the Code.

L61 Area to ΘF, see L35. To be not less than 0.08.

L62 Maximum Righting Arm, see L37. To be not less than 0.25.

L63 Initial Fluid Metacentric Height, see L4. To be not less than 0.10

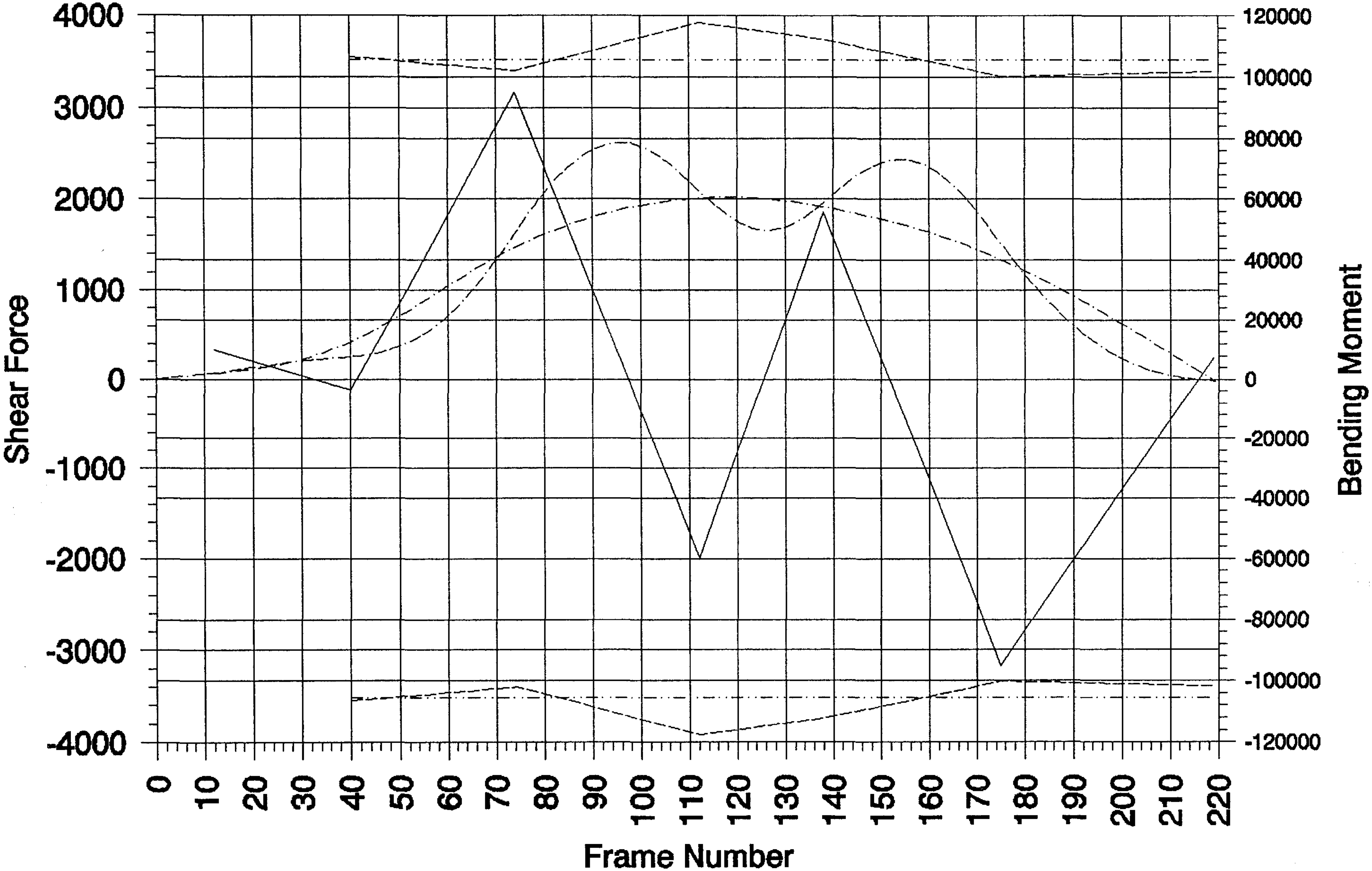
L64 Fluid Metacentric Height, see L4. To be positive throughout the voyage.

L65/
L66 **Note.** The "Required Values" may vary for particular vessels and circumstances. The Ship's approved Stability and Loading Manual should be examined for specific requirements.

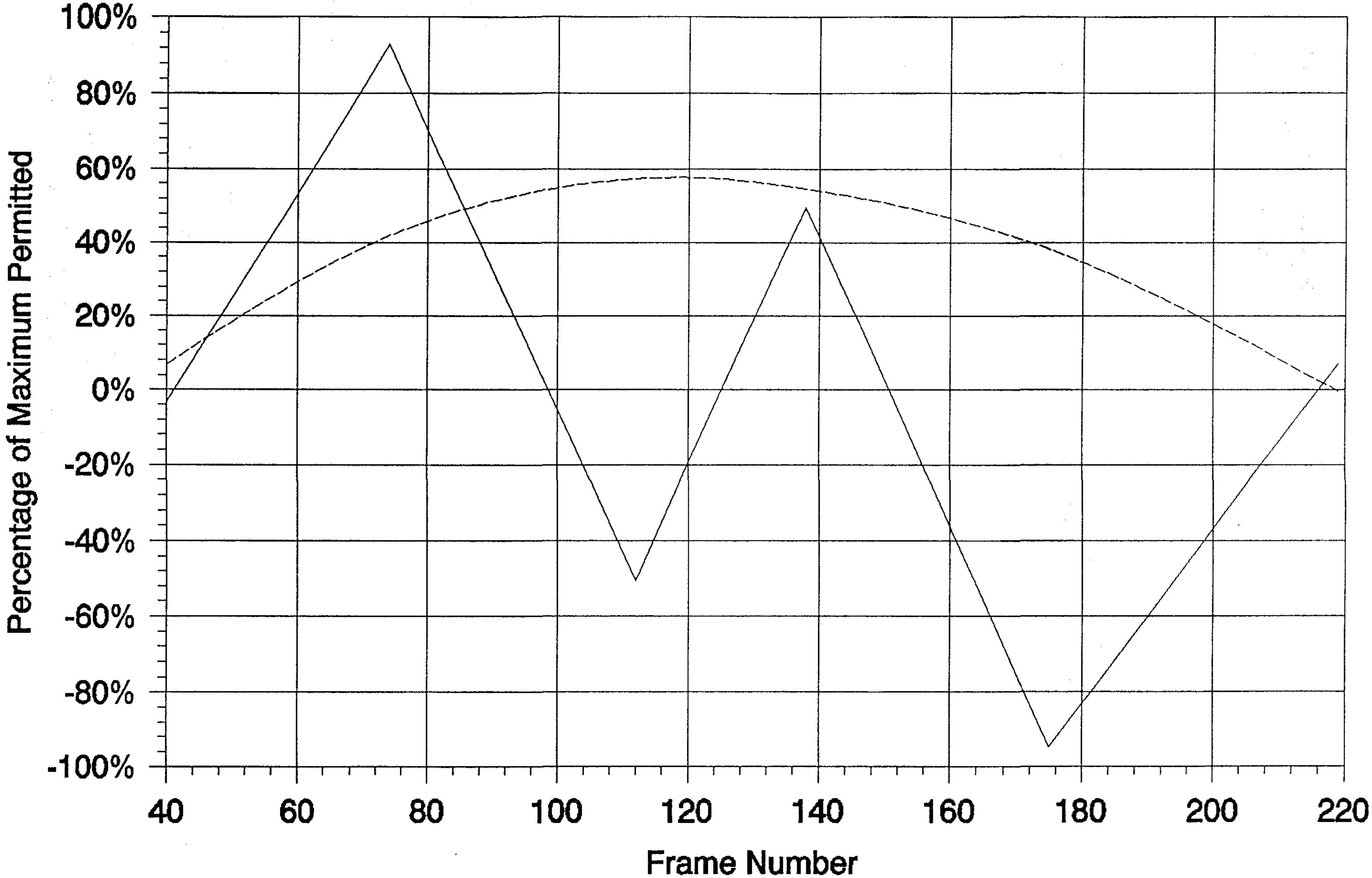
Appendix 10.X4 (1)

1	Shear Forces and Bending Moments																						
2	REGINA OLDENDORFF, Ore. Alternate holds.																						
3	Draft Midships	9.95																					
4	Trim	0.048																					
5	Bulkhead. Position P		Frame 12	84.07		Frame 40	60.83		Frame 74	32.61		Frame 112	1.07		Frame 138	-20.51		Frame 175	-51.22		Frame 219	-82.15	
6	Item	Longitudinal	Weight	Distance	Moment	Weight	Distance	Moment	Weight	Distance	Moment	Weight	Distance	Moment	Weight	Distance	Moment	Weight	Distance	Moment	Weight	Distance	Moment
7		Centre of	W	LCG-P	W*D	W	LCG-P	W*D	W	LCG-P	W*D	W	LCG-P	W*D	W	LCG-P	W*D	W	LCG-P	W*D	W	LCG-P	W*D
8		Gravity LCG																					
9	*Cargo Holds*																						
10	*No 1*	-64.98																			8450.0	17.17	145086.5
11	*No 3*	-10.13													9400.0	10.38	97572.0	9400.0	41.09	386246.0	9400.0	72.02	676988.0
12	*No 5*	45.80							8700.0	13.19	114753.0	8700.0	44.73	389151.0	8700.0	66.31	576897.0	8700.0	97.02	844074.0	8700.0	127.95	1113165.0
13																							
14	*Oil Tanks*																						
15	*No 4 FOT*	44.26							89.4	11.65	1041.5	89.40	43.19	3861.2	89.4	64.77	5790.4	89.4	95.48	8535.9	89.4	126.41	11301.1
16	*FO Service*	65.39				32.9	4.56	150.0	32.9	32.78	1078.5	32.90	64.32	2116.1	32.9	85.90	2826.1	32.9	116.61	3836.5	32.9	147.54	4854.1
17	*FO Settling*	62.90				34.1	2.07	70.6	34.1	30.29	1032.9	34.10	61.83	2108.4	34.1	83.41	2844.3	34.1	114.12	3891.5	34.1	145.05	4946.2
18	*DO Service*	68.72				8.5	7.89	67.1	8.5	36.11	306.9	8.50	67.65	575.0	8.5	89.23	758.5	8.5	119.94	1019.5	8.5	150.87	1282.4
19	*DO Setting*	68.72				8.5	7.89	67.1	8.5	36.11	306.9	8.50	67.65	575.0	8.5	89.23	758.5	8.5	119.94	1019.5	8.5	150.87	1282.4
20																							
21	*Fresh Water*																						
22	*No 1 FWT*	86.37	23.5	2.30	54.1	23.5	25.54	600.2	23.5	53.76	1263.4	23.50	85.30	2004.6	23.5	106.88	2511.7	23.5	137.59	3233.4	23.5	168.52	3960.2
23	*Drinking Water*	86.36	9.5	2.29	21.8	9.5	25.53	242.5	9.5	53.75	510.6	9.50	85.29	810.3	9.5	106.87	1015.3	9.5	137.58	1307.0	9.5	168.51	1600.8
24																							
25	*Provisions*	88.27	0.8	4.20	3.4	0.8	27.44	22.0	0.8	55.66	44.5	0.80	87.20	69.8	0.8	108.78	87.0	0.8	139.49	111.6	0.8	170.42	136.3
26																							
27																							
28																							
29																							
30																							
31																							
32																							
33																							
34																							
35																							
36																							
37																							
38	Deadweight Weight		33.8			117.8			8907.2			8907.2			18307.2			18307.2			26757.2		
39	Ship Weight		447.5			2611.5			3576.6			4743.7			5644.4			6758.8			7826.5		
40	Buoyancy Even Keel		151.9			2838.3			8956.1			16332.0			21380.6			28559.8			34344.3		
41	Trim Factor		42.3			207.5			377.3			446.1			418.9			276.8			54.9		
42	Trim Correction L4*L41		2.0			10.0			18.1			21.4			20.1			13.3			2.6		
43	Buoyancy L40+L42		153.9			2848.3			8974.2			16353.4			21400.7			28573.1			34346.9		
44	Shear Force L38+L39-L43		327.4			-119.0			3509.6			-2702.5			2550.9			-3507.1			236.8		
45	Difference SF-SF						3628.6			6212.1			5253.4			6058.0			3743.9				
46	Bulkhead Factor						0.19			0.23			0.30			0.23			0.18				
47	Correction L45*L46						344.7			714.4			788.0			696.7			337.0				
48	Lesser Correction								344.7			714.4			696.7			337.0					
49	Corrected Shear Force L44±L48					-119.0			3164.9			-1988.1			1854.2			-3170.1			236.8		
50	Maximum Permitted Shear Force					3550.0			3400.0			3920.0			3740.0			3340.0			3390.00		
51	Shear Force as Percentage of Maximum Permitted L49/L50*100					-3.4%			93.1%			-50.7%			49.6%			-94.9%			7.0%		
52																							
53	Deadweight Moment				79.3			1219.5			120338.2			401271.4			691060.8			1253274.9			1964603.0
54	Ship Moment				2193.1			34761.1			121433.2			253830.7			366539.9			558018.3			785290.0
55	Buoyancy Moment Even Keel				440.2			28672.4			191907.5			590654.9			997596.8			1764640.9			2747861.9
56	Trim Factor				194.1			3000.1			11503.4			24823.5			34278.1			45239.3			50277.2
57	Trim Correction L4*L56				9.3			144.0			552.2			1191.5			1645.3			2171.5			2413.3
58	Buoyancy Moment L55+L57				449.5			28816.4			192459.7			591846.4			999242.1			1766812.4			2750275.2
59	Bending Moment L53+L54-L58				1822.9			7164.2			49311.7			63255.7			58358.6			44480.8			-382.[illegible]
60	Maximum Permitted Bending Moment							105400.0			105400.0			105400.0			105400.0			105400.0			105400.[illegible]
61	Bending Moment as Percentage of Maximum Permitted L59/L60*100							6.8%			46.8%			60.0%			55.4%			42.2%			-0.[illegible]

Shear Forces and Bending Moments
REGINA OLDENDORFF
Ore. Alternate Holds.



Shear Forces and Bending Moments
REGINA OLDENDORFF
Ore. Alternate Holds.



Shear Force and Bending Moment Calculation

Note. In some Ships' Stability and Loading Manuals the Ship Weight and Buoyancy; Ship Moment and Buoyancy Moment; and Trim Corrections are combined in the structure of the tables and not determined separately. When the information is presented in this way it may be unsuitable for entry in the Form which accompanies these notes.

L1 Identification of worksheet
L2 Identification of ship and condition.
L3 Draft Midships, observed or calculated.
L4 Trim, observed or calculated.
L5 Bulkhead identification by Frame Number.
Position expressed as distance from Midpoint, sign negative if Position forward of Midpoint.
L6/
L8 Titles of columns. Abbreviated formulae.
Item.
Longitudinal Centre of Gravity. Distance from Midpoint, sign negative if Centre forward of Midpoint.
Weight = V*D
Where:- V = Volume.
D = Density.
Value can be estimated, calculated or given.
Distance = LCG - P
Where:- LCG = Longitudinal Centre of Gravity of Weight from Midpoint. Sign negative if LCG forward of Midpoint.
P = Position of Bulkhead from Midpoint. Sign negative if Position forward of Midpoint.
Moment = W*D
Where:- W = Weight
D = Distance
L9/
L37 Details of weights.
All weights which occur in positions abaft (ie aft of) a particular bulkhead must be listed in the column for that bulkhead. For example, if there are 8700 tonnes in No 5 Hold, and No 5 Hold is abaft the bulkhead at Frame 74 (the bulkhead which separates Nos 4 and 5 Holds) the 8700 tonnes must be entered in that column. The 8700 tonnes is also abaft all the bulkheads which are forward of Frame 74, so 8700 tonnes must be repeated in all the columns forward of the first entry.
When every weight has been entered in this manner their distances and moments must be calculated and entered too. A weight entered in several columns will have a different distance in each.
Care should be taken to enter only appropriate items, as some may be included in the Ship Weight and Moment. In the case of the REGINA OLDENDORFF Lubricating Oil, Cooling Water, Crew and Stores are included in the Ship Weight and therefore not entered separately here.
L38 Deadweight Weight. The total of all weights entered above for each section.
L39 Ship Weight. The weight of the ship for each section. Extract from Ship's Stability and Loading Manual. In the case of the REGINA OLDENDORFF this is not purely the Light Weight, certain other weights being included as described above, L37.
L40 Buoyancy Even Keel. Extract from Ship's Stability and Loading Manual. Value corresponding to Draft Midships.
L41 Trim Factor. Extract from Ship's Stability and Loading Manual. Value corresponding to Draft Midships.

```
L42 Trim Correction = T*TF
       Where:- T  = Trim, see L4
               TF = Trim Factor, see L41
L43 Buoyancy = BEK+TC
       Where:- BEK = Buoyancy Even Keel, see L40
               TC  = Trim Correction, see L42
L44 Shear Force = DW+SW-B
       Where:- DW = Deadweight Weight
               SW = Ship Weight
               B  = Buoyancy
L45/
L49 Calculation of Bulkhead Correction for those bulkheads for which a
    Bulkhead Factor is given.
L45 Difference = SF-SF
       Where:- SF = Shear Force
       The lower value is subtracted from the higher to obtain the
       absolute difference between adjacent values.
       NB. -100 is lower than 100.

       For instance:-
       Frame A Shear Force = 1000
       Frame B Shear Force =  100
       Difference = 1000 - 100 = 900

       Frame A Shear Force = 1000
       Frame B Shear Force = -100
       Difference = 1000 - -100 = 1100

       Frame A Shear Force = -1000
       Frame B Shear Force =   100
       Difference = 100 - -1000 = 1100

       Frame A Shear Force = -1000
       Frame B Shear Force =  -100
       Difference = -100 - -1000 = 900

L46 Bulkhead Factor, Extract from Ship's Stability and Loading Manual.
L47 Correction = D*BF
       Where:- D  = Difference, see L45
               BF = Bulkhead Factor, see L46
L48 Lesser Correction. The lesser value of adjacent corrections,
    see L47.
L49 Corrected Shear Force = SF±C
       Where:- SF = Shear Force, see L44
               C  = Correction, see L48
    The sign used is such as to reduce the absolute value of the Shear
    Force.
    For example:-
    Frame 74 Shear Force  3509.6
             Correction    344.7
    Corrected Shear Force = 3509.6 - 344.7 = 3164.9
    Frame 112 Shear Force -2702.5
             Correction     714.4
    Corrected Shear Force = -2702.5 + 714.4 = -1998.1
L50 Maximum Permitted Shear Force. Extract from Ship's Stability and
    Loading Manual. Different values may be given for different
    circumstances. The appropriate value must be used.
L51 Shear Force as Percentage of Maximum Permitted = CSF/MPSF*100
       Where:- CSF  = Corrected Shear Force, see L49
               MPSF = Maximum Permitted Shear Force, see L50
L52
L53 Deadweight Moment. The total of moments entered above.
L54 Ship Moment. The moment for the ship and certain weights not
```

entered above for each section. Extract from Ship's Stability and Loading Manual.

L55 Buoyancy Moment Even Keel. Extract from Ship's Stability and Loading Manual. Value corresponding to Midships Draft.

L56 Trim Factor. Extract from Ship's Stability and Loading Manual. Value corresponding to Midships Draft.

L57 Trim Correction = T*TF
  Where:- T = Trim, see L4
  TF = Trim Factor, see L56

L58 Buoyancy Moment = BMEK+TC
  Where:- BMEK = Buoyancy Moment Even Keel, see L55
  TC = Trim Correction, see L57

L59 Bending Moment = DM+SM-BM
  Where:- DM = Deadweight Moment, see L53
  SM = Ship Moment, see L54
  BM = Buoyancy Moment, see L58

L60 Maximum Permitted Bending Moment. Extract from Ship's Stability and Loading Manual. Different values may be given for different circumstances. The appropriate value must be used.

L61 Bending Moment as Percentage of Maximum Permitted = BM/MPBM*100
  Where:- BM = Bending Moment, see L59
  MPBM = Maximum Permitted Bending Moment, see L60

1	**Trim and Initial Stability**						
2	*REGINA OLDENDORFF. Grain. Density 0.803 MT/CM. Arrival Ceuta for Bunkers.*						
3	LCG, LCB and LCF from Midpoint.						
4	Negative if Centre forward of Midpoint.						
5	Identity	Weight	Longitudinal	Longitudinal	Vertical	Vertical	Free Surface
6			Centre of	Moment	Centre of	Moment	or Volumetric
7			Gravity		Gravity		Heeling Momnt
8		W	LCG	W*LCG	VCG	W*VCG	
9	*Crew/Stores*	*372.1*	*54.58*	*20309*	*8.49*	*3159.1*	*0*
10	*No 3 DB*	*490.0*	*-9.72*	*-4763*	*1.04*	*509.6*	*36*
11	*No 4 DB*	*860.0*	*17.00*	*14620*	*1.40*	*1204.0*	*5*
12	*Aft Peak*	*100.0*	*88.72*	*8872*	*8.70*	*870.0*	*270*
13	*FO 3C*	*11.5*	*16.84*	*194*	*0.02*	*0.2*	*3042*
14	*FO 4C*	*1.0*	*44.26*	*44*	*0.00*	*0.0*	*0*
15	*FO Set*	*24.0*	*62.90*	*1510*	*11.10*	*266.4*	*51*
16	*FO Serv*	*21.0*	*65.39*	*1373*	*11.52*	*241.9*	*25*
17	*DO P*	*9.1*	*66.24*	*603*	*0.25*	*2.3*	*63*
18	*DO S*	*9.1*	*66.24*	*603*	*0.25*	*2.3*	*63*
19	*DO Set*	*7.7*	*68.72*	*529*	*11.85*	*91.2*	*1*
20	*DO Serv*	*8.5*	*68.72*	*584*	*12.00*	*102.0*	*1*
21	*FW 1P*	*32.0*	*86.40*	*2765*	*12.20*	*390.4*	*115*
22	*FW 2P*	*25.0*	*92.23*	*2306*	*12.50*	*312.5*	*20*
23	*FW 2S*	*25.0*	*92.23*	*2306*	*12.50*	*312.5*	*20*
24	*Drinking Wtr*	*30.0*	*86.40*	*2592*	*12.20*	*366.0*	*105*
25	*Cooling Wtr*	*11.0*	*85.28*	*938*	*2.18*	*24.0*	*1*
26	*Total Free Surface Moments*						*3818*
27							
28	*Grain Cargo*						*Volumetric*
29							*Heeling*
30							*Moment*
31	*No 1 Hold*	*5305.8*	*-65.67*	*-348432*	*8.36*	*44356.5*	*1882*
32	*No 2 Hold*	*6313.0*	*-36.28*	*-229036*	*7.79*	*49178.3*	*535*
33	*No 3 Hold*	*2294.0*	*-10.12*	*-23215*	*4.80*	*11011.2*	*8900*
34	*No 4 Hold*	*6469.0*	*16.42*	*106221*	*7.79*	*50393.5*	*547*
35	*No 5 Hold*	*5169.0*	*46.08*	*238188*	*8.11*	*41920.6*	*2024*
36	*Total Volumetric Heeling Moments*						*13888*
37							
38	Deadweight	*27588*					
39	Light Ship	*8051*	*12.04*	*96950*	*10.12*	*81468*	
40	Displacement	*35639*		*-103940*		*286183*	*3818*

41	Draft at Centre of Flotation	*10.238*	Hydrostatic Table
42	Longitudinal Centre of Gravity	*-2.916*	L40 LM/W
43	Longitudinal Centre of Buoyancy	*-3.555*	Hydrostatic Table
44	Moment to Change Trim One Centimetre	*483.84*	Hydrostatic Table
45	Trim	*0.471*	(L42-L43)*L40W/L44/100
46	Length Between Perpendiculars	*183.00*	Ship's Particulars
47	Longitudinal Centre of Flotation	*1.458*	Hydrostatic Table
48	Difference of Draft Forward	*-0.239*	-(L43/2+L47)*L45/L46
49	Difference of Draft Aft	*0.232*	(L43/2-L47)*L45/L46
50	Draft Forward	*9.999*	L41+L48
51	Draft Aft	*10.470*	L41+L49
52	Transverse Metacentre	*9.483*	Hydrostatic Table
53	Vertical Centre of Gravity	*8.030*	L40 VM/W
54	Metacentric Height	*1.453*	L52-L53
55	Free Surface Effect	*0.107*	L40 FSM/W Exclude VHM
56	Fluid Metacentric Height	*1.346*	L54-L55
57	Permissible Grain Heeling Moment	*11433*	Hydrostatic Table
58	Volumetric Heeling Moment	*13888*	Total VHM
59	Density of Grain Cargo	*0.803*	MT/CM
60	Grain Heeling Moment	*11146*	L58*L59 <L57

METHOD OF OBTAINING VALUES OF VOLUMETRIC HEELING MOMENTS (VHMs)

(This method must be used when the ship has no loading computer. The way in which the information is presented is likely to vary from one shipbuilder to another.)

The loading used for this example is the grain loading (Three Rivers/Oran) which appears in Appendix 10.X5.

Compartment:	No. 1 H	No. 2 H	No. 3 H	No. 4 H	No. 5 H
Compartment full?	Yes	Yes	No	Yes	Yes
Ends trimmed?	No	Yes	N/A	Yes	No
VHMs (filled—ends trimmed), values read from hydrostatic table (Appendix 10.X6, page 2)		533		547	
VHMs (filled—ends untrimmed), values read from hydrostatic table (Appendix 10.X6, page 2)	1,882				2,024
VHMs (unfilled), value read from graph in hydrostatic table (Appendix 10.X6, page 3)*,			8,900		
Summary of volumetric heeling moments:	1,882	533	8,900	547	2,024

*To obtain the VHMs for the unfilled No. 3 hold proceed as follows.

- Enter the graph with the volume of cargo in No. 3 hold. (No. 3 hold is to contain 2,294 tonnes, at density 0.803, so cargo volume = 2,294/0.803 = 2,856.8 m^3).
- On the graph volume 2,856.8 m^3 correspond to 8.1 m distance of grain surface from top of hatch coaming.
- For grain surface at 8.1 m, the curve of shifting moment value can be read from the scale as 8,900 m^4

A note on the graph states that shifting moments (ie, VHMs) have been increased 12 per cent in accordance with the regulations, to take account of the vertical shift of the grain surface. No further correction is needed for this purpose.

Grain loading calculation data

Summary table of the grain capacities and transverse volumetric heeling moments for 'filled-ends trimmed' and 'filled-ends not trimmed'.

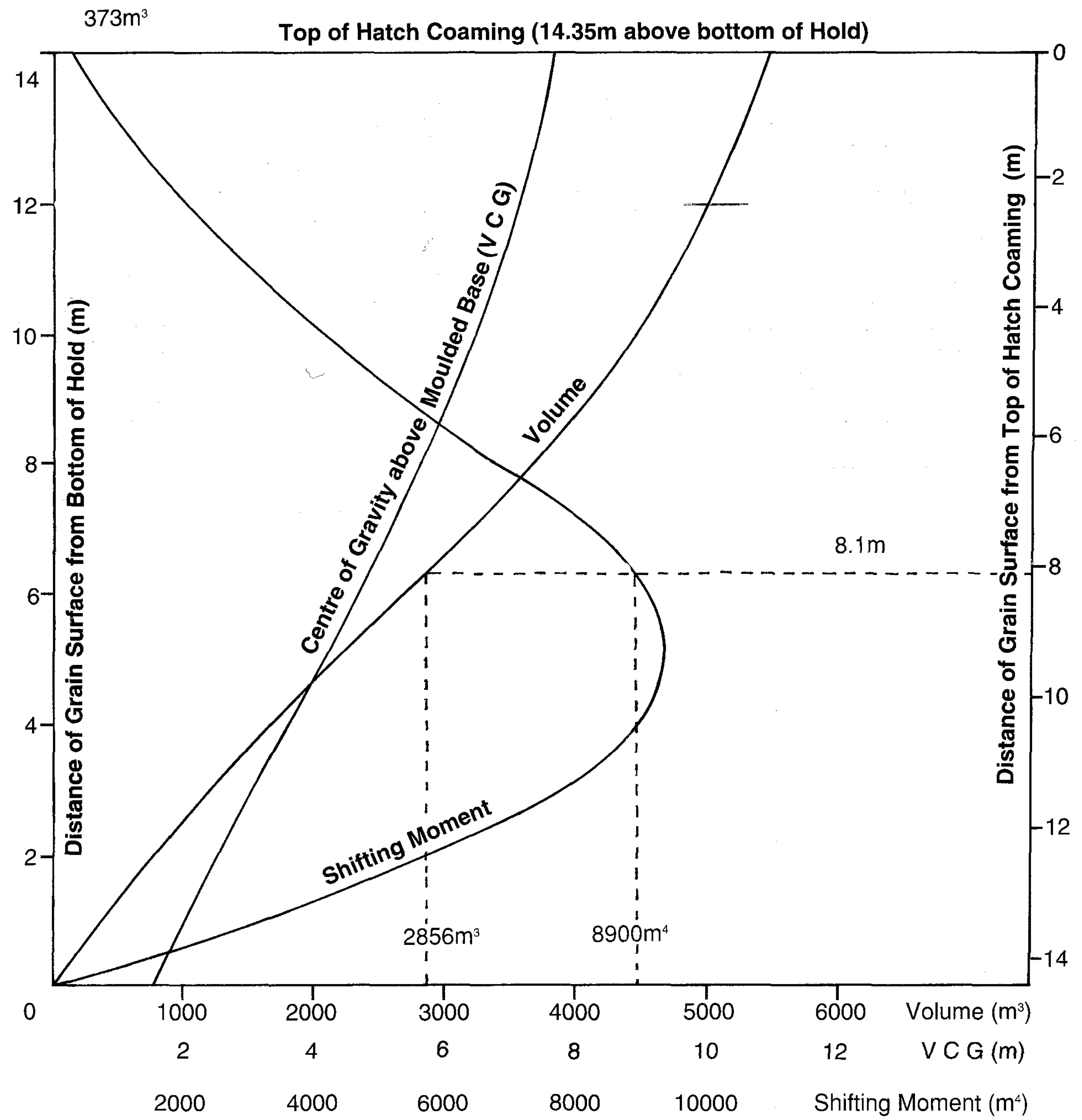
Notes:
** The whole volume of the compartment.*
*** The whole volume of the compartment minus the volume of voids in the untrimmed ends.*
**** The geometrical centre of the compartment.*

Compartment	Filled-ends trimmed				Filled-ends not trimmed			
	Capacity	Centre of gravity		Volumetric Heeling Moments	Capacity	Centre of gravity		Volumetric Heeling Moments
		KG	LCG			KG***	LCG	
	(M^3)	(M)	(M)	(M^4)	(M^3)	(M)	(M)	(M^4)
No. 1 Cargo hold	6,848.0	8.36	−65.67	586	6,351.8**	8.36	−65.67	1882
No. 2 Cargo hold	7,866.9	7.79	−36.28	533	7,562.5**	7.79	−36.28	1762
No. 3 Cargo hold	5,503.4	7.76	−10.12	373	5,264.2**	7.76	−10.12	1333
No. 4 Cargo hold	8,060.5	7.79	16.42	547	7,721.0**	7.79	16.42	1921
No. 5 Cargo hold	6,699.1	8.11	46.08	535	6,344.2**	8.11	46.08	2024
No. 2 TST (P&S)					1,216.4*	12.51	−35.87	451
No. 3 TST (P&S)					854.8*	12.51	−9.72	317
No. 4 TST (P&S)					1,253.4*	12.51	16.84	463
No. 5 TST (P&S)					1,097.0*	12.60	46.47	415

Curves of Volume, V C G & Shifting Moment for No3 Cargo Hold

Total Capacity	5503m³
Full-hold Heeling Moment	373m⁴
Max Slack-hold Heel Moment	9356m⁴

Note
Shifting moments have been increased 12% of the Transverse Shift as the adverse effect of the Vertical Shift of the Grain surface in accordance with the regulation.



CORRECTIONS TO HEELING MOMENTS TO OBTAIN ACTUAL GRAIN HEELING MOMENTS: THE BACKGROUND

THE grain heeling moments (sometimes called shifting moments or upsetting moments) for each cargo space are a measure of the free surface effect of the grain within that space. Grain heeling moments, like the free surface moments in a ballast tank, are zero when the compartment is empty, and are small when a compartment is almost full. (Filling a hold completely full with grain is not a practical possibility.) The free surface area of grain in the hold of a conventional bulk carrier is greatest when the hold is about half full, and it is at this level that the grain heeling moments are at a maximum.

There are several alternative methods for obtaining accurate values for grain heeling moments. They vary according to whether the ends have been trimmed, the centre of gravity assumed for the grain, the method of assessing the amount of grain in the compartment, whether the compartment is full or part full, the method of calculation of the grain heeling moments, and the units used to describe the density of the grain. The calculations provided in the loading manual for each ship are based upon a particular method, using some of the above alternatives, but the grain stability calculation forms issued by the various national authorities must provide for all the alternatives, and are worded accordingly.

It is not always clear which corrections must be applied to grain heeling moments in which circumstances: the factors which govern this are described below.

Trimmed and untrimmed ends

The values of the grain heeling moments for holds with untrimmed ends are larger than those for holds with trimmed ends, because when the ends are untrimmed the grain has more room in which to shift. A hold with untrimmed ends is a hold in which the grain at the hold ends lies at its natural angle of repose. A hold with trimmed ends is one in which the bulk grain has been trimmed so as to fill all spaces under the decks and hatchcovers to the maximum extent possible.[46]

When holds are full, values must always be read from the correct set of tables for the condition of each hold at the time.

Centre of gravity assumed

Volumetric centres of gravity are usually used in loading manuals. The volumetric centre of gravity (CG) is the centre of the volume required to contain the cargo, including broken stowage. For a full compartment the volumetric CG is at the centre of volume of the compartment: this disregards the fact that there will actually be broken stowage in the form of underdeck voids which the cargo has not filled, so the true CG of the cargo will be lower.

CGs which are obtained by measurement-for example, by measurement of the ullage of a part filled compartment-take account of the actual space occupied and do not include the underdeck voids which reduce the vessel's capacity. CGs obtained by measurement are known as 'true' or 'cargo' centres of gravity.

Method of assessing the amount of grain in the compartment

When a proposed loading plan shows a compartment to be full the intended condition is the same as when the compartment has been filled. In both cases the broken stowage is included, and in both cases the heeling moments will require no correction if the volumetric CGs have been used.

A part-filled compartment in a proposed loading plan, calculated with the help of the stowage factor, will not be filled to the same level as the same compartment when filled in reality. This is because the stowage factor does not remain constant throughout the full height of the stow: most of the broken stowage occurs at the top of the hold, under the deckhead. When the height of cargo in a part filled compartment has been obtained by measurement a true or cargo GG will have been calculated, and a correction must be applied to the grain heeling moments to obtain the value as for a volumetric CG.

Whether the compartment is full or part full

As noted above, when a compartment has been part filled the CG calculated from a measured ullage or height of grain will be a true or cargo centre, and not a volumetric centre. A correction must be applied to the heeling moments to take account of this.

Method of calculation of the grain heeling moments

The method of calculation adopted in the loading manual may be to use volumetric CGs. Alternatively, true or cargo centres may be used, in which case they must be corrected for vertical shift of grain surface which occurs as the cargo settles during the voyage. A table of correction factors to allow for vertical shift of grain surface will be provided in the loading manual, or this correction will be incorporated into the tables or curves of shifting moments.

Units used to describe the density of the grain

When the volumetric heeling moments have been calculated they must always be corrected to take account of the stowage factor of the cargo. For this calculation it is essential that the units used are consistent. If the heeling moments are expressed in M4 they must be divided by the stowage factor expressed in m^3 /tonne, and not by the stowage factor expressed in cuft/ton.

An alternative method of making this correction is to multiply the volumetric heeling moments by the specific gravity of the cargo. This has exactly the same effect as dividing by the stowage factor.

Corrections: a summary

Corrections are made to the tabulated values of the heeling moments by the use of multipliers, with three possible values (1.0, 1.06, 1.12) to be used as required. The occasions for their use are as follows.

Correction x 1.0 (ie, no correction), when:
- Compartment is full, and volumetric centre has been used.
- Compartment IS riot full, but volumetric Centre for full Compartment has been used.
- The table or curve of heeling moments has been adjusted for vertical shift of grain surface by the use of multiplier 1,12 (or + 12%).

Correction x 1.06, when:
- Compartment Is full and a true or cargo centre has been used-not a volumetric centre.

Correction x 1.12, when:
- Compartment is part filled, unless volumetric centres for the full compartment have been used, or the table or curve of heeling moments has been adjusted for vertical shift of grain surface by use of the multiplier 1. 12.

The ship's loading manual ought to make clear, with explanation and example, which corrections have to be applied.

LOADING CALCULATIONS FOR A TIMBER VOYAGE

Regina Oldendorff, imaginary voyage from Umea, Sweden (in the north Baltic) to Alexandria, Egypt, via the Kiel Canal, bunkering at Brunsbuttel at the Canal exit.

The steps in the calculation are described below, followed by a summary of the data and limits used. Then worked examples of some of the calculations are provided.

Procedure for calculations

Arrival at Kiel is likely to be the worst condition for stability. Stability is likely to be least as the quantities of fuel, carried low in the vessel, will be at a minimum. The shallowest minimum draft also occurs at this point.

Calculation 1: trim & initial stability calculation, attached.

Kiel arrival, with maximum cargo.
The holds and decks have been filled to capacity.
Draft is less than the limit.
However, the fluid metacentric height is negative.

Stability can be improved by filling ballast tanks, thereby adding weight low in the vessel.

Calculation 2: trim and initial stability calculation (not attached).

Kiel arrival, as *Calculation 1*, but with ballast added.
The Nos. 2, 3 and 4 DB ballast tanks have been filled to capacity with water at a density of 1.000 mt/m^3, the dock density at Umea.
The mean draft is 9.595 m, which exceeds the limit.
The fluid metacentric height is still negative.

Free surface effect is already at a minimum, and no further improvements can be made to stability by changing the bunker or ballast tanks. Taking bunkers instead of ballast would not normally help, as bunkers are less dense than ballast water. To achieve a further improvement in stability there is no alternative but to reduce the tonnage of cargo carried on deck.

Calculation 3: trim and initial stability calculation (not attached).

Kiel arrival, as *Calculation 2*, but with deck cargo reduced.
The deck cargo has been reduced evenly until the stablity criteria are met. The amount of cargo to remove can be found by trial and error, or by calculation.

Calculation for tonnage of deck cargo to remove.
An approximate value for the amount of cargo to remove can be obtained by solving the familiar equation

$GG_1 = w \times d/(W - w)$ for w. Rearrange this to become:

$w = GG_1 \times W/(d + GG_1)$

where
GG_1 = the increase required in G_1M
W = Displacement
d = distance of top layer of deck cargo from the ship's centre of gravity (ie KG of layer of deck cargo – KG of ship)
w = tonnage of deck cargo to remove

After removing the unwanted deck cargo the vessel is found to be trimmed by the stern, the draft aft exceeding the limit.
Trim can be reduced by transferring weight of deck cargo forward.

Calculation 4: trim and initial stability calculation. (Not attached.)

Kiel arrival, as *Calculation 3* but weight has been transferred from deck cargo on No. 5 hatch to No. 1 hatch until the appropriate trim is achieved for even keel in dock water. Quantity to transfer is found from trimming tables, or by calculation or trial and error.

Vessel is now at the required draft and trim, and has sufficient initial fluid metacentric height.

Calculation 5: statical & dynamical stability calculation (not attached).

As the vessel is now at a satisfactory draft and trim, and has an acceptable initial fluid metacentric height, it is necessary to ensure that she satisfies all the stability criteria.

The calculation shows that the area under the curve of statical stability from 0° to 30° is 0.051 m-rad, which is less than 0.055 m-rad, so a further improvement in the stability is required.

(When the ship is provided with simplified stability information in the form of a curve or table of initial metacentric height versus draft, or any other measurement of stability, the statical and dynamical stability calculations will not be required.)

Calculation 6: trim & initial stability calculation. and statical and dynamical stability calculation (not attached)

To improve the stability, deck cargo can be reduced with or without the taking of more ballast. However, the ballast tanks are large, and a more economical improvement may be achieved by taking additional diesel bunkers in Umea, and retaining them throughout the voyage. Recalculate as *Calculations 4 & 5*, but with an additional 45 mt in the diesel oil tank, and a reduction of 45 mt of deck cargo.

The area under the curve is now 0.054 m-rad, so a slightly larger tonnage must be transferred.

Calculation 7. trim & initial stability calculation. and statical and dynamical stability calculation (not attached)

Repeat *Calculation 6* using 62 mt In place of 45 mt (a. transfer of 15 mt appears to cause an increase of 0.001 m-rad). The area under the curve is 0.056 m-rad, which is acceptable. However, the transfer of weight from the deck cargo to the diesel oil tank has caused the vessel to trim slightly by the stern. This must be corrected by a transfer of deck cargo from aft to forward.

Calculation 8: trim & initial stability calculation, attached.

As *Calculation 7*, but weight has been transferred from deck cargo on No. 5 to deck cargo on No. 1 until the appropriate trim is achieved for even keel in dock water.

Calculation 9: statical & dynamical stability calculation, attached.

As *Calculation 8*. The calculation shows that the condition satisfies all the stability criteria. The deck cargo distribution continues to be acceptable, because all the values in *Condition 9* are less than In *Condition 1*, which used maximum values.

Further calculations

Using the tonnages in *Calculation 9* as a basis, the bunker quantities must be adjusted to obtain the tonnages aboard at each stage in the voyage. Using these figures the trim and initial stability calculation, and the statical and dynamical stability calculation, must be completed for departure Umea, departure Kiel and arrival Alexandria.

The calculations, which are not attached, show draft, trim and stability to be satisfactory for every stage in the voyage, and confirm that arrival Kiel was the worst condition. Once the Kiel Canal with its draft restrictions has been passed the stability can be further improved by ballasting No. 5 DB tanks.

Allowance for absorption of moisture, and for icing.

In a case such as this one, when the ship's stability condition does not allow any more weight to be carried on deck, the effect of these allowances is to reduce the amount of cargo which can be carried on deck.

When absorption and icing can be expected, as on an ocean voyage in high latitudes, it is reasonable to allow 20 per cent of the weight of the deck cargo for these factors. For a voyage from Umea to Alexandria, on the other hand, it is reasonable to assume that absorption will increase as the voyage goes on, but icing will disappear after the first few days, so an allowance of 10 per cent is appropriate.

Deck cargo tonnage = wx100/110

Where w = calculated value of weight to load on deck

100 = constant

110 = 100 + percentage allowed for absorption and icing

	Calculated weight		Deck cargo tonnage
Deck cargo 1	986	x100/110 =	896
Deck cargo 2	1,091		992
Deck cargo 3	749		681
Deck cargo 4	1,122		1,020
Deck cargo 5	722		656
Total tonnage of deck cargo to be carried			4,245 mt

Data used in the worked example

Consumptions

Fuel oil:	31 mtpd (metric tonnes per day)
Diesel oil:	2.5 mtpd
Fresh water:	nil (vessel has an evaporator)

Distances and consumptions

Umea to Kiel 900 nm @ 14,5 kts = 2.6 days
FO: 81 mt DO 7 mt
Kiel to Alexandria 3444 nm @ 14.5 kts = 9.9 days
FO: 307 mt DO 25 mt
Reserve, 3 days' steaming
FO: 93 mt DO 8 mt

Fuel totals–minimum quantities to satisfy consumption requirements at each point in voyage.

	FO	DO
Umea Departure	174	15
Kiel Arrival	111	6
Kiel Departure	477	26
Alexandria Arrival	111	6

Tank capacities

Fuel oil tanks 95% full with density 0.950 mt/m^3

	m^3	mt
FO2	334	301
FO4	325	293
Diesel oil tank 95 per cent full with density 0.850 mt/m^3		
DO	190	153
Settling & Service tanks 50% full		
FO Service	35	17
FO Settling	72	34
DO Service	10	4
DO Settling	10	4

Cargo Stowage Factors

Deck cargo: 63 ft^3/lt = 0.56955 mt/m^3
Holds: 68 ft^3/lt = 0.52767 mt/m^3
(NB: these values are useful for this example, but are not typical of timber from Umea.)

Constant weights

Settling and service tanks	59 mt
Lubricating oil	56 mt
Fresh water	50 mt
Other tanks	31 mt
Stores	45 mt

Changes of draft and trim

Dock density at Kiel 1.013 mt/m^3
Limiting draft at Kiel 9.5 m.

To calculate seawater draft corresponding to maximum canal draft:

Draft change = Wx(1 −SD/ DD)/TPC/100
where W = Displacement
SD = Seawater density
DD = Dockwater density
TPC = Tonnes per centimetre immersion
Draft change = 33265x (1-1.025/1.013)/38.0/100
= −0.102 m

So seawater draft 9.398 m corresponds to 9.5 m in canal.

To calculate seawater trim corresponding to even keel canal trim:

Trim change (m) = (SLCB-DLCB) xW/MCTC/100
where SLCB = Seawater longitudinal centre of buoyancy
DLCB = Dockwater longitudinal centre of buoyancy
W = Displacement
MCTC = Moment to change trim one centimetre
Trim change (m) = ([−3.903] − [−3.855])x33265/467.34/100
= − 0.034 m

This shows that the vessel will trim by the head when passing from sea water to canal water. The trim in sea water must be 0.034 m by the stern for even keel in the canal.

Stability requirements

The stability requirements are governed by the IMO International Convention on Load Lines, the IMO Code of Safe Working Practices for Timber Deck Cargoes, flag State regulations and classification society rules. The minimum criteria are given in the ship's loading manual and should be read with care, because in some cases they are different from the IMO recommendations.

The *Regina Oldendorff* is required to comply with the UK Merchant Shipping (Load Line) Rules 1968, Schedule 4, Part 1, Para. 2. When carrying timber she is permitted to have an initial metacentric height of not less than 0.05 metres.

Deck cargo

Limiting drafts 4.5 m

Limiting height:

	Draft (m)	Density (mt/m^3)	SW Draft (m)
Umea	9.7	1.000	
Kiel	9.5	1.013	9.398
Brunsbuttel	10.4	1.003	
Alexandria	13.5	1.025	

1	**Trim and Initial Stability**						**Calculation 1**
2	*REGINA OLDENDORFF. Kiel. Arrival. Maximum Cargo.*						
3	LCG, LCB and LCF from Midpoint.						
4	Negative if Centre forward of Midpoint.						
5	Identity	Weight	Longitudinal	Longitudinal	Vertical	Vertical	Free Surface
6			Centre of	Moment	Centre of	Moment	or Volumetric
7			Gravity		Gravity		Heeling Momnt
8		W	LCG	W*LCG	VCG	W*VCG	
9	*Deck Cargo 1*	*1006*	*-63.76*	*-64143*	*17.59*	*17696*	
10	*Deck Cargo 2*	*1290*	*-35.87*	*-46272*	*17.21*	*22201*	
11	*Deck Cargo 3*	*886*	*-9.72*	*-8612*	*17.20*	*15239*	
12	*Deck Cargo 4*	*1327*	*16.84*	*22347*	*17.21*	*22838*	
13	*Deck Cargo 5*	*1014*	*44.82*	*45447*	*17.22*	*17461*	
14	*Hold 1*	*3411*	*-65.63*	*-223864*	*8.23*	*28073*	
15	*Hold 2*	*3916*	*-36.28*	*-142072*	*7.70*	*30153*	
16	*Hold 3*	*2709*	*-10.14*	*-27469*	*7.63*	*20670*	
17	*Hold 4*	*4043*	*16.42*	*66386*	*7.69*	*31091*	
18	*Hold 5*	*3407*	*46.22*	*157472*	*7.99*	*27222*	
19	*W Ballast 1*		*-65.24*		*1.44*		
20	*W Ballast 2*		*-35.84*		*1.34*		
21	*W Ballast 3*		*-9.72*		*1.34*		
22	*W Ballast 4*		*17.00*		*1.46*		
23	*W Ballast 5*		*47.40*		*1.95*		
24	*Fuel Oil 1*		*-35.86*		*0.74*		
25	*Fuel Oil 2*		*-9.72*		*0.74*		
26	*Fuel Oil 3*		*16.84*		*0.74*		
27	*Fuel Oil 4*	*93*	*44.26*	*4116*	*0.74*	*69*	*1469*
28	*FO Ser & Set*	*51*	*58.48*	*2982*	*12.04*	*614*	
29	*Diesel Oil*	*8*	*66.24*	*530*	*1.38*	*11*	*210*
30	*DO Ser & Set*	*8*	*68.72*	*550*	*12.02*	*96*	
31	*Lub Oil*	*56*	*73.74*	*4129*	*6.74*	*377*	
32	*Fresh Water*	*50*	*88.59*	*4430*	*13.26*	*663*	*476*
33	*Other Tanks*	*31*	*82.23*	*2549*	*2.13*	*66*	
34	*Stores*	*45*	*27.33*	*1230*	*16.53*	*744*	
35							
36							
37							
38	Deadweight	*23351*					
39	Light Ship	*8051*	*12.04*	*96950*	*10.12*	*81468*	
40	Displacement	*31402*		*-103314*		*316751*	*2155*
41				Draft at Centre of Flotation	*9.011*	Hydrostatic Table	
42				Longitudinal Centre of Gravity	*-3.290*	L40 LM/W	
43				Longitudinal Centre of Buoyancy	*-4.085*	Hydrostatic Table	
44				Moment to Change Trim One Centimetre	*454.87*	Hydrostatic Table	
45				Trim	*0.549*	(L42-L43)*L40W/L44/100	
46				Length Between Perpendiculars	*183.00*	Ship's Particulars	
47				Longitudinal Centre of Flotation	*-0.333*	Hydrostatic Table	
48				Difference of Draft Forward	*-0.274*	-(L46/2+L47)*L45/L46	
49				Difference of Draft Aft	*0.275*	(L46/2-L47)*L45/L46	
50				Draft Forward	*8.737*	L41+L48	
51				Draft Aft	*9.286*	L41+L49	
52				Transverse Metacentre	*9.361*	Hydrostatic Table	
53				Vertical Centre of Gravity	*10.087*	L40 VM/W	
54				Metacentric Height	*-0.726*	L52-L53	
55				Free Surface Effect	*0.069*	L40 FSM/W	
56				Fluid Metacentric Height	*-0.795*	L54-L55	
57				Permissible Grain Heeling Moment		Hydrostatic Table	
58				Volumetric Heeling Moment		Total VHM	
59				Density of Grain Cargo		MT/CM	
60				Grain Heeling Moment		L58*L59 <L57	

1 **Trim and Initial Stability** — Calculation 8

2 *REGINA OLDENDORFF. Kiel. Arrival. Even Keel (Density 1.013).*

3 LCG, LCB and LCF from Midpoint.

4 Negative if Centre forward of Midpoint.

	Identity	Weight	Longitudinal Centre of Gravity	Longitudinal Moment	Vertical Centre of Gravity	Vertical Moment	Free Surface or Volumetric Heeling Momnt
5–8		W	LCG	W*LCG	VCG	W*VCG	
9	*Deck Cargo 1*	*986*	*-63.76*	*-62867*	*17.55*	*17304*	
10	*Deck Cargo 2*	*1091*	*-35.87*	*-39134*	*16.86*	*18394*	
11	*Deck Cargo 3*	*749*	*-9.72*	*-7280*	*16.85*	*12621*	
12	*Deck Cargo 4*	*1122*	*16.84*	*18894*	*16.86*	*18917*	
13	*Deck Cargo 5*	*722*	*44.82*	*32360*	*16.57*	*11964*	
14	*Hold 1*	*3411*	*-65.63*	*-223864*	*8.23*	*28073*	
15	*Hold 2*	*3916*	*-36.28*	*-142072*	*7.70*	*30153*	
16	*Hold 3*	*2709*	*-10.14*	*-27469*	*7.63*	*20670*	
17	*Hold 4*	*4043*	*16.42*	*66386*	*7.69*	*31091*	
18	*Hold 5*	*3407*	*46.22*	*157472*	*7.99*	*27222*	
19	*W Ballast 1*		*-65.24*		*1.44*		
20	*W Ballast 2*	*826*	*-35.84*	*-29604*	*1.34*	*1107*	
21	*W Ballast 3*	*582*	*-9.72*	*-5657*	*1.34*	*780*	
22	*W Ballast 4*	*858*	*17.00*	*14586*	*1.46*	*1253*	
23	*W Ballast 5*		*47.40*		*1.95*		
24	*Fuel Oil 1*		*-35.86*		*0.74*		
25	*Fuel Oil 2*		*-9.72*		*0.74*		
26	*Fuel Oil 3*		*16.84*		*0.74*		
27	*Fuel Oil 4*	*93*	*44.26*	*4116*	*0.74*	*69*	*1469*
28	*FO Ser & Set*	*51*	*58.48*	*2982*	*12.04*	*614*	
29	*Diesel Oil*	*70*	*66.24*	*4637*	*1.38*	*97*	*210*
30	*DO Ser & Set*	*8*	*68.72*	*550*	*12.02*	*96*	
31	*Lub Oil*	*56*	*73.74*	*4129*	*6.74*	*377*	
32	*Fresh Water*	*50*	*88.59*	*4430*	*13.26*	*663*	*476*
33	*Other Tanks*	*31*	*82.23*	*2549*	*2.13*	*66*	
34	*Stores*	*45*	*27.33*	*1230*	*16.53*	*744*	
35							
36							
37							
38	Deadweight	*24826*					
39	Light Ship	*8051*	*12.04*	*96950*	*10.12*	*81468*	
40	Displacement	*32877*		*-126677*		*303741*	*2155*

	Item	Value	Source
41	Draft at Centre of Flotation	*9.398*	Hydrostatic Table
42	Longitudinal Centre of Gravity	*-3.853*	L40 LM/W
43	Longitudinal Centre of Buoyancy	*-3.903*	Hydrostatic Table
44	Moment to Change Trim One Centimetre	*464.74*	Hydrostatic Table
45	Trim	*0.035*	(L42-L43)*L40W/L44/100
46	Length Between Perpendiculars	*183.00*	Ship's Particulars
47	Longitudinal Centre of Flotation	*0.311*	Hydrostatic Table
48	Difference of Draft Forward	*-0.018*	-(L46/2+L47)*L45/L46
49	Difference of Draft Aft	*0.017*	(L46/2-L47)*L45/L46
50	Draft Forward	*9.380*	L41+L48
51	Draft Aft	*9.415*	L41+L49
52	Transverse Metacentre	*9.400*	Hydrostatic Table
53	Vertical Centre of Gravity	*9.239*	L40 VM/W
54	Metacentric Height	*0.161*	L52-L53
55	Free Surface Effect	*0.066*	L40 FSM/W
56	Fluid Metacentric Height	*0.095*	L54-L55
57	Permissible Grain Heeling Moment		Hydrostatic Table
58	Volumetric Heeling Moment		Total VHM
59	Density of Grain Cargo		MT/CM
60	Grain Heeling Moment		L58*L59 <L57

1 **Statical and Dynamical Stability** — **Calculation 9**

2 *REGINA OLDENDORFF. Kiel. Arrival.*

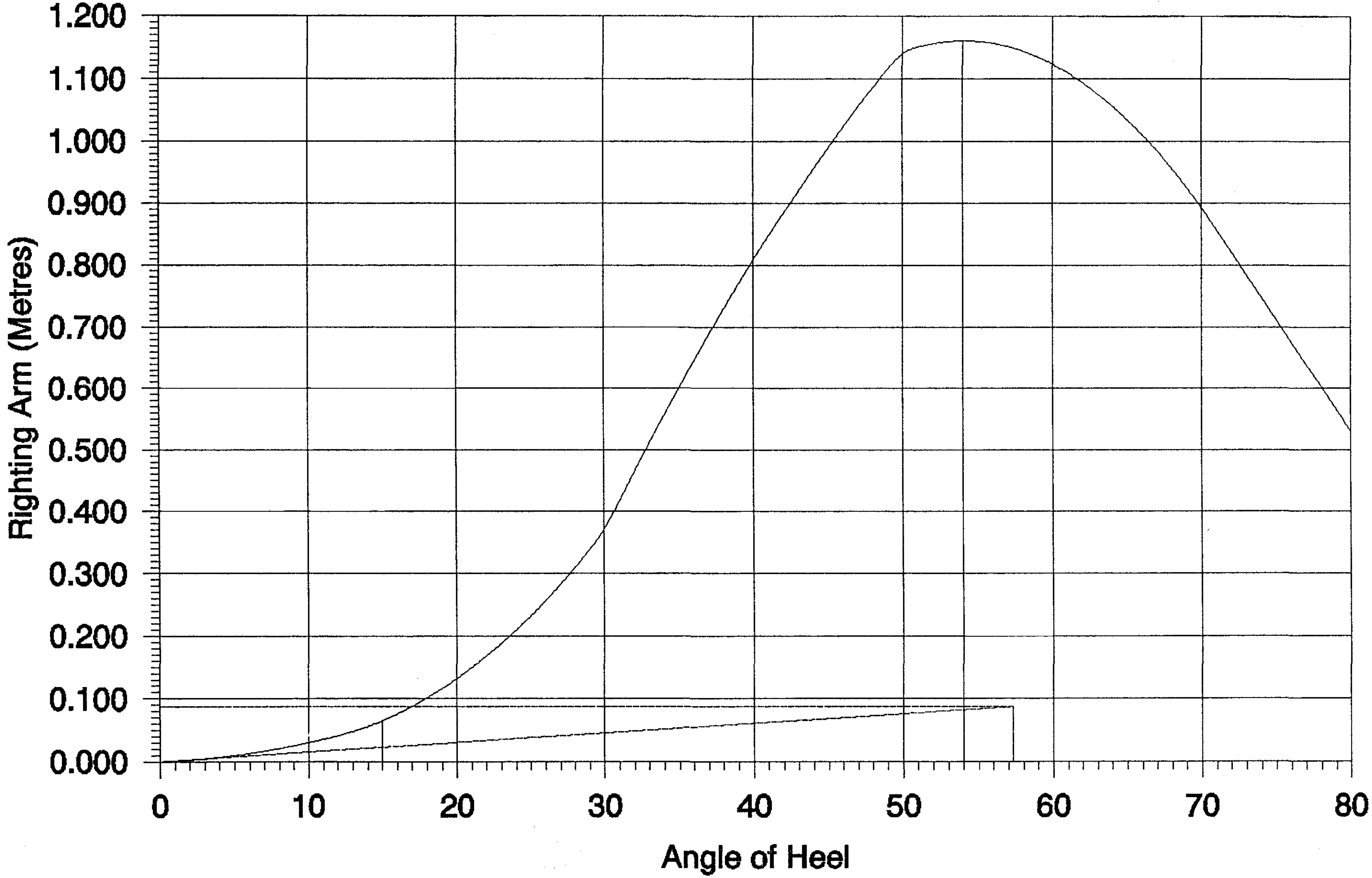
						Required Values *
3	Displacement				*32877*	
4	Fluid Metacentric Height				*0.095*	
5	Vertical Centre of Gravity				*9.239*	
6	Free Surface Effect				*0.066*	
7	Fluid Vertical Centre of Gravity L5+L6				*9.305*	
8	Assumed Vertical Centre of Gravity				*7.000*	
9	Difference between Vertical Centres of Gravity L8-L7				*-2.305*	
10	Righting Arm Curve					
11	Angle	Sine	Correction	Assumed	Righting	
12	of		L9*Sine	Righting	Arm	
13	Heel			Arm	ARA+C	
14	*0.00*	*0.000*	*0.000*	*0.000*	*0.000*	
15	*10.00*	*0.174*	*-0.400*	*0.430*	*0.030*	
16	*12.00*	*0.208*	*-0.479*	*0.520*	*0.041*	
17	*20.00*	*0.342*	*-0.788*	*0.920*	*0.132*	
18	*30.00*	*0.500*	*-1.153*	*1.520*	*0.368*	
19	*40.00*	*0.643*	*-1.482*	*2.290*	*0.808*	
20	*50.00*	*0.766*	*-1.766*	*2.910*	*1.144*	
21	*60.00*	*0.866*	*-1.996*	*3.120*	*1.124*	
22	*70.00*	*0.940*	*-2.166*	*3.060*	*0.894*	
23	*80.00*	*0.985*	*-2.270*	*2.800*	*0.530*	
24	**IMO International Convention on Load Lines 1966**					Required
25	Righting Arm at 0° Heel [A]				*0.000*	Values *
26	Righting Arm at 15° Heel [DE]				*0.065*	
27	Righting Arm at 30° Heel [FG]				*0.368*	
28	Area to 30° (L26*4+L25+L27)*15/3/57.3 [AFG]				*0.055*	=>0.055
29	Angle of Flooding				*47*	
30	θF, Angle of Flooding L29, or 40°, whichever less.				*40*	
31	Half θF L30/2				*20*	
32	Righting Arm at 0° Heel L25 [A]				*0.000*	
33	Righting Arm at Half θF° Heel L31 [HI]				*0.132*	
34	Righting Arm at θF° Heel L30 [JK]				*0.808*	
35	Area to θF (L33*4+L32+L34)*L31/3/57.3 [AJK]				*0.155*	=>0.090
36	Area 30° to θF L35-L28 [GFJK]				*0.100*	=>0.030
37	Maximum Righting Arm [LM]				*1.161*	=>0.20
38	Angle of Maximum Righting Arm [M]				*54*	=>30°
39	Initial Fluid Metacentric Height L4 [BC]				*0.095*	=>0.15
40	**IMO International Grain Code 1991**					
41	Heeling Arm Curve					
42	Volumetric Heeling Moment of grain					
43	Density of Cargo					
44	Heeling Arm at 30° L42/L3*L43 [AN]					
45	Heeling Arm at 40° L44*0.8 [OK]					
46	Angle of Heel due to Grain Shift, [Q], at					
47	Intersection of Righting and Heeling Arm curves [P]					<=12
48	Angle where difference between					
49	Righting Arm and Heeling Arm curves is maximum [R]					
50	Limit of Residual Dynamic Stability,					
51	Least value of L29, L49 and 40°					
52	Midpoint of range (L47+L51)/2 [S]					
53	Ordinate L51-L52					
54	Differences between Righting and Heeling Arms					
55	At Angle of Heel due to Grain Shift L47 [P]					
56	At Midpoint of range L52 [TU]					
57	At Limit of Residual Dynamic Stability L51 [JO]					
58	Residual Dynamic Stability (L56*4+L55+L57)*L53/3/57.3 [PJO]					=>0.075
59	Initial Fluid Metacentric Height L4 [BC]					=>0.30
60	**IMO Code of Safe Practice for Ships <100m Carrying Timber Deck Cargoes**					
61	Area to θF L35				*0.155*	=>0.08
62	Maximum Righting Arm L37				*1.161*	=>0.25
63	Initial Fluid Metacentric Height L4				*0.095*	=>0.10
64	Fluid Metacentric Height to be positive throughout voyage.					

65 * *The Ship's Stability and Loading Manual should be checked for*

66 specific requirements, see Note in explanation.

Appendix 10.X8 (7)

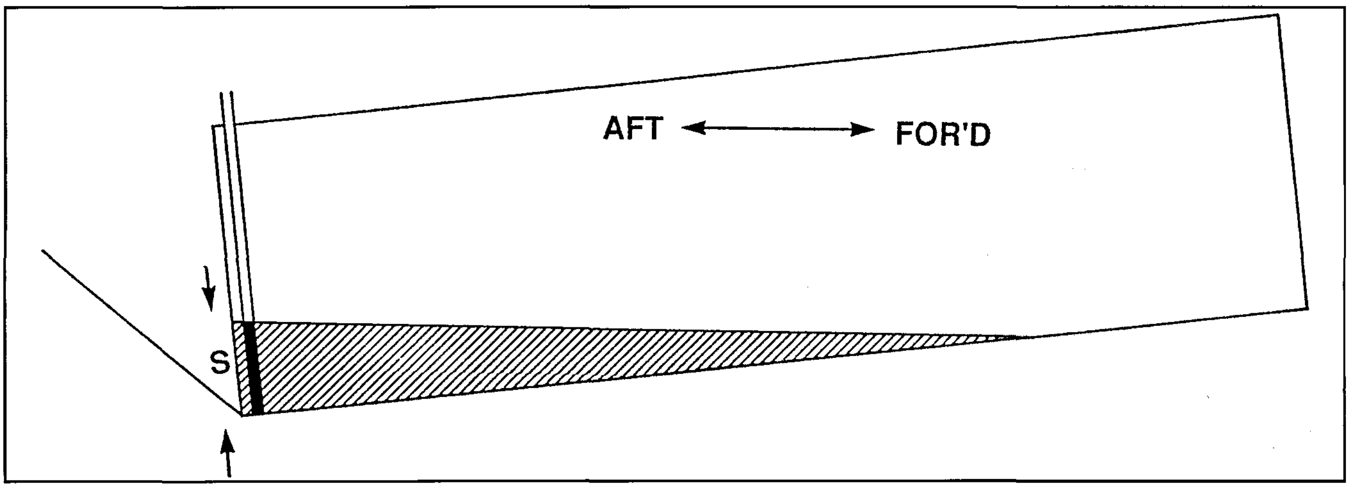
Curve of Statical Stability
REGINA OLDENDORFF
Kiel. Arrival.



WEDGE FORMULA: VOLUME IN TANK, ALLOWING FOR TRIM

WHEN a ship is trimmed it is necessary to allow for the trim, to obtain an accurate volume, and tonnage, of liquid in the tank. The tank calibration tables may contain trim corrections, but for an accurate result it is necessary to interpolate carefully between two values for trim. The tank calibration tables for the Regina Oldendorff give readings for every 0.5 m of trim from 0.5 m by the head to 3.0 m by the stern, which is a very useful spread, but many ships are not so well equipped.

Accurate values are important when calculating the tonnage of strippings remaining in ballast tanks, and the wedge formula provides a method for taking account of the trim, when the actual sounding is small.



Wedge Formula:

$$V = \frac{LS^2B}{2T}$$

where V = volume of liquid in tank (m^3)
L = vessel's length between perpendiculars (m)
B = breadth of tank (m)
T = trim of vessel (m)
S = sounding (m)

$$W = VD$$

where W = tonnage in tank (mt)
V = volume of liquid in tank (m^3)
D = density of liquid in tank (mt/m^3)

The wedge formula:

- Only applies for small soundings below a maximum value which can be calculated (see below),
- Assumes that the tank is box shaped-it ignores the turn of the bilge, and any tapering of the ship along the length of the tank, so its results are only approximate,
- Assumes that the sounding is measured at the after end of the tank. On bulkers this assumption is almost always justified.

The wedge formula does not apply when the liquid in the tank is deep enough to reach the forward end of the tank, ie when:

Length of tank (m) $<$ S x L/T (symbol meanings as above)

Hold inspection certificate

Appendix 14.1

Ship Inspection Report and Treatment Order
Export Control Act 1982

Sequence number (Central office) . . . .
Form number (State Dept.) . . . .

Original

A. Report

Name of ship . . . . .Registered call signal . . . .

Previous names . . . .

De rat Cert. Date of issue: . . . . .Unique number . . . .

Details of loading	Port	Expected Tonnage	Date
	PORT LINCOLN	50,000	8.1.92.

Details of last two cargoes	Commodity	Origin	Date
	COAL	AUSTRALIA	DEC 91
	MAIZE	U.S.A	SEPT.91

Details of last grain or oilseed cargo (where applicable): Type of grain . . . AS ABOVE . . . .Origin. . . . . .Date . . . .

Agent. . PATRICK S. LEIGH. . . . . .Marine Surveyor. . . D. CARLTON . . . .

Inspectors M. RIDGWAY. C. SOUTHAM. . . .Place of inspection . . PORT LINCOLN. . . . .

Times and dates of all inspections and re-inspections. . 2h. 30. m. 7. 1. 92. . . . .

Site of inspection	No1	No2	No3	No4	No5	No6	No7						
Hatch covers	C	C	C	C	C	C	C						
Deck beams	C	C	C	C	C	C	C						
~~Cable casings~~	—	—	—	—	—	—	—						
~~Pipe casings~~	—	—	—	—	—	—	—						
~~Ventilation trunking~~	—	—	—	—	—	—	—						
STEEL bulkheads	C	C	C	C	C	C	C						
~~Spar ceilings~~	—	—	—	—	—	—	—						
Exposed metal surfaces	C	C	C	C	C	C	C						
STEEL tank top ceilings	C	C	C	C	C	C	C						
Bilges	C	C	C	C	C	C	C						
Total infestation for hold (L or H)													

Stores-structure	C	Stores-foodstuff	C	Galley areas	C	Focsle lockers	C	Mast houses	C	Weather deck	C	Other	

Key: L Light infestation; H Heavy infestation; T Trogoderma sp; G Grain; M Mineral residue; R Rodents; S Scale; W Water; O Other; C Clear;
Note more than one letter indicates more than one condition present eg. GS indicates grain plus scale in inspected areas.
*Insert number of insects found in particular sites to 50 then use '50+'.

Residue type

B. Treatment Order

To the master: You are advised that the ship is not to be used for the export of prescribed goods until the action indicated in the following TICKED boxes has been taken, after which a further inspection will be required.

Clean														
Descale**partial														
Dismantle/Remove														
High volume spray														
Gas fumigate														

**delete as applicable

Key for disposal of residues: 1. to be retained for further inspection 2. to be removed prior to treatment 3. to remain in hold during treatment 4. on completion for action, residue to be handed to a Quarantine officer/retained on board for disposal.

Additional Treatment and Remarks

Treatment ordered by Marine Surveyor (Tick appropriate box) Clean ☐ Descale ☐ Other ☐

Date and Time of issue. . . 7. 1. 92. . . 6:00. pm . . . . . .Inspector's Signature . . . M. W. Ridgway . . .

Office Use Only

Details of treatment

Spray or Bait

Chemicals used . . . .% active ingredients. . . . . .Treatment carried out by . . . .

Fumigation

Fumigant used. . . . . .Dosage . . . . .Exposure period. . . . .

Insect sample no. holds etc. . . . . Insect sample no. Storerooms, galley areas etc . . . . Ships hold Cert. issued (tick) ☑

E 248—3/88

SHIP INSPECTION REPORT AND TREATMENT ORDER: STANDARDS REQUIRED OF VESSELS LOADING GRAIN, PLANTS AND PLANT PRODUCTS

The following notes outline the standards of cleanliness and pest control required of ships presented for loading of grain, plants and plant products in Australia.

1. Grain, Plants and Plants Product Orders

Application for Permission to Load

Ships' masters must apply for permission to load 500 t or more of grain (wheat, barley, oats, sorghum, lupins and dried field peas), or plants and plants products for which the importing country requires a phytosanitary or other official certificate under the provisions of the Ministerial Orders. *These commodities are referred to as prescribed* goods in the rest of this document.

The application must include details of other cargo, including empty sacks, that could harbour pests, so that this can be inspected prior to loading.

Inspectors

Vessels in which it is intended to export prescribed goods examined by authorised inspectors of the Department Health or State Departments of Agriculture/Primary Industries on behalf of the Department of Primary Industries and Energy. The Orders require that the holds of cargo-loading vessels be free from pests or from residues which could harbour pests. Inspectors are empowered to board ships and order cleaning and treatment, or to require other measures necessary to ensure satisfactory outturn of the cargo overseas, before issuing a permit to load.

For grain loading ships, the holds must also be inspected by an approved marine surveyor. An inspector will not issue a permit to load until he has seen a certificate from the surveyor stating that the holds will not contaminate or otherwise affect the grain.

2. Trogoderma Species

There is a nil tolerance for Trogoderma species (cabinet beetles) on ships loading prescribed goods.

Fumigation is required for any level of infestation by these species in hold spaces.

Cargo-Loading Holds

There is a nil tolerance for live pests in holds nominated to load prescribed goods.

All parts of these holds must be free from any previous cargo residue that can harbour pests, including spaces beneath timber linings and the interiors of trunkings and casings.

Masters or agents are legally required to make facilities available to permit inspection of ledges, casings, bulkheads etc. that would otherwise be inaccessible. All non-infestible residue, including loose flaking rust and paint scale, that could conceal pests or infestible residues must be removed to the extent necessary to enable the inspector to carry out a thorough inspection.

Adequate natural light is necessary for all hold spaces and asssociated areas. Inspections are not undertaken before half an hour after sunrise or after half an hour before sunset. Hatch covers must be opened sufficiently to provide good natural lighting.

4. Non-Cargo-Loading Holds

Non-cargo-loading holds are examined when a full cargo is not to be carried.

Pest infestation in non-cargo-loading holds must be controlled to such an extent that the risk of cross-infestation to prescribed goods is eliminated.

5. Ship Stores and Associated Galley Areas

Experience has shown that storerooms are often infested with insect pests to such a degree that a risk of cross-infestation to cargo-loading holds exists. Inspectors are empowered to inspect these areas and to withhold permits to load until that risk has been eliminated.

These areas, being partly or fully lit by artificial light, may be inspected outside the time limits laid down for holds.

6. Other Areas

Areas of ships such as mast houses, fo'c's'le lockers weather deck etc. must not present a cross-infestations or contamination risk to the cargo-loading holds. The permit to load will be withheld until such risks have been removed.

7. Ship Inspection Report and Treatment Order

Following initial inspection of a vessel, a Ship Inspection Report is issued to the master. If cleaning, treatment or other measures are required, this is indicated in the combined Treatment Order. Where hold fitments such as pipe casings, cable casings, spar ceilings and timber bulkhead linings are required to be removed, to facilitate further inspection or cleaning and disinfestation measures, this is also included on the Treatment Order. All procedures in the nomination holds to remove the risk of infestation or infection of the cargo are specified.

Criteria for deciding on treatments followed by inspectors when issuing Treatment Orders are laid down in the Grain, Plants and Plant Products Orders.

Subsequent Ship Inspection Reports and Treatment Orders may be issued as a result of reinspection of a vessel. A re-fumigation is normally ordered following an unsatisfactory fumigation treatment of cargo holds.

8. Permit to Load

When the inspector is satisfied that prescribed goods loaded onto a vessel will not become infested by pests, and, in the case of grain-loading vessels, has seen a certificate from a marine surveyor that the ship is suitable for the carriage of prescribed grain, a permit to load is issued in accordance with the Orders.

Mate's receipt

Appendix 14.2

LITORAL AGÊNCIA MARITIMA, COMISSÁRIA
DE DESPACHOS E SERVIÇOS CORRELATOS LTDA.

Nº 01

MATE'S RECEIPT

Port of S.Frco.Sul,6th july, de 198 8.-

RECEIVED in apparent good order and condition on board the m/s [redacted]
from Messrs CEVAL AGRO INDUSTRIAL S.A.
the undermentioned goods destined to the port of "ANY IRANIAN SOUTHERN PORTS"

Marks and Numbers	Number of pieces	Class of packages	Said to contain	Gross weight Kilos	Cubic measurement
IN BULK			"BRAZILIAN SOYA BEAN		
			MEAL PELLETS		
			IN BULK"	3.028.190 KGS	

"CLEAN ON BOARD"

"Said to be said to weigh"
"quantity and quality unknown"

All terms, conditions, liberties, exceptions, clauses and arbitration clause of Charter Party dated 30-06-88 and any addenda thereto, are herewith incorporated.

THE CARRIAGE OF THE GOODS SPECIFIED HEREIN IS SUBJECT TO THE CONDITIONS AS CONTAINED IN THE BILL OF LADING FOR THIS SHIPMENT

STOWAGE

Hatches	U. T. D.	L. T. D.	L. H.	Total
I				
II				
III				
IV				
V				
VI				
			Grand Total	

M.V. RUBENS
O.N. 366 308
G.R.T. 17.965.73
N.R.T. 11.236.17
B.H.P. 11200

Port of S.Frco.do Sul,6th july, de 198 8.-

Chief Officer

Letter of instruction to agents

Appendix 14.3

Use Owners' Headed Notepaper
(or state name of Owners)

Specimen Letter of Instruction to Agents

mv................
at................
Date.............

To (Agents)

Dear Sirs

I hereby confirm that you have authority to sign bills of lading on my behalf <u>in strict conformity with mate's or tally clerk's receipts signed by me or by the chief mate</u>*, in respect only of the following cargo loaded at this port and said to be:

Please note that this authority is non-transferable, and that you do not have authority to sign any bill of lading which does not specifically incorporate the terms, conditions and exceptions of the charterparty dated .... and/or the Hague Rules (or rules having a similar effect).

The charterers' instructions/charterparty governing this voyage stipulate that the port of discharge will be .... The destination shown on the bills of lading must be consistent with this provision.

Please ensure that all bills are properly dated.

"Freight prepaid" bills are not to be issued unless expressly authorised by my owners.

Do not hesitate to refer to my owners on this or any other matter concerning the issuance of bills of lading.

Yours faithfully

Master

Signature of any nominated signatory:

Signed for receipt:

*Delete when the cargo is a bulk cargo for which no mate's or tally clerk's receipts have been issued.

Completed letter of instruction — Appendix 14.4

[redacted]MANAGEMENT LTD.

m.v. "[redacted]..................."

At Sao.Francisco.Do.Sul..

Date 8th July 1988.........

To: Agencia Maritima [redacted] Ltda
Rua Almirante Guilhen, 2 - SALA 108
SAO FRANCISCO DO SUL
S.C.
BRAZIL

Dear Sirs,

I hereby confirm that you have authority to sign Bills of Lading on my behalf in conformity with Mates receipts, in respect of the following cargo loaded at this port and said to be:

APPROX 24530 M/T

SOYA BEAN MEAL PELLETS, IN BULK

Please note that you do not have authority to sign any Bill of Lading which does not specifically incorporate the terms, conditions and exceptions of the Charter Party dated ~~29th~~ 30th June 1988............. and/or the Hague Rules (or legislation of similar effect).

The destination shown in the Bills of Lading should be consistent with the provisions of the Charter Party governing this voyage/Charterers' instructions, which stipulate that the vessel will discharge at BANDAR ABBAS or. BANDAR SHAH BAHAR

Please ensure that all bills are properly dated.

On no account should "freight prepaid" bills be issued without the express authority of my Owners, to whom you should refer on this and any other matter concerning the signing and issuing of Bills of Lading.

Yours faithfully,

MASTER
S.F. Williams

[redacted]
PORT OF REG: [redacted]
OFFICIAL No: [redacted]
GROSS TONNAGE: [redacted]
NETT TONNAGE: [redacted]

BM6D

Bill of lading (page 2) — Appendix 14.5

Page 2

BILL OF LADING B/L No.: **1**

Islamic Republic of Iran Shipping Lines

Shipper:
CEVAL AGRO INDUSTRIAL S.A.

Consignee:
"TO THE ORDER OF BANK SEPAH
TEHRAN IRAN"

Notify address: (carrier not to be responsible for failure to notify)
M/S GOVERNMENT TRADING CO FOR
SANDOGH OMRANEA MARATEA TEHRAN
ISLAMIC REPUBLIC OFF IRAN-185
SEPAHBOD GHARANI AVE TEHRAN 15 -
IRAN

*Local vessel: | *from:

(Ocean) vessel: "RUBENS" | Port of loading: SAO FRANCISCO DO SUL-BRAZIL

Port of discharge: "SEE BELOW" | *Final destination (if on-carriage): | Freight payable at: AS PER CHARTER PARTY | Number of original Bs/L: 4(FOUR)

Marks & Nos.:	Number and kind of packages; description of goods:	Gross weight kg
	"BRAZILIAN SOYA BEAN MEAL PELLETS IN BULK"	24.530.000 KGS
	"CLEAN ON BOARD"	
	"FREIGHT PAYABLE AS PER CHARTER PARTY"	
	- CREDIT NR CA/415515/8	
	- SHIPMENT THROUGHT ISLAMIC REPUBLIC OF IRAN SHIPPING CO.	
	- UNDER WRITE: "SHERKATE BIMEH IRAN" TLX 214154	
	" ONE PORT OUT OF BANDAR CHAH BAHAR, BANDAR ABBAS IN CHARTERERS OPTION"	

PARTICULARS FURNISHED BY SHIPPER OF GOODS

COPY NOT NEGOTIABLE

Shipper's Ref.:

Freight and charges:

SHIPPED in apparent good order and condition unless otherwise specified on board the aforementioned vessel the goods described above (the particulars given being supplied by the Shipper and the measurement, weight, quantity, brand, contents, marks, numbers, quality and value being unknown to the carrier) for the carriage to the port of discharge or so near thereunto as she may safely go subject to the terms, conditions and exemptions of this Bill of Lading.

In accepting this Bill of Lading the Owners of the goods expressly accept and agree to all its stipulations on both pages, whether written, printed, stamped or otherwise incorporated, as fully as if they were all signed by the Owners of the Goods.

In WITNESS whereof the Master, Purser or Agent of the said vessel has signed the number of original Bills of Lading stated above, all of this tenor and date, one of which being accomplished, the others, stand void. One of the Bills of Lading must be given up, fully endorsed in exchange for the goods.

Place and date of issue: S.Frco.do Sul, 10 JUL 1988

for the Master:
Agência Marítima CARGONAVE Ltda.
ON BEHALF OF MASTER'S AUTHORITY

*) Applicable only when document used as a Through Bill of Lading

CONTI SINGAPORE. 06-09 '91 14:19 P.01

CONTINENTAL GRAIN (S) PTE. LTD.

ORIGINAL

332762

PRIMARY PRODUCTION DEPARTMENT
REPUBLIC OF SINGAPORE

PHYTOSANITARY CERTIFICATE

This is to certify that the plants or plant products described below have been inspected according to appropriate procedures and are considered to be free from quarantine pests, and practically free from other injurious pests; and that they are considered to conform with the current phytosanitary regulations of the importing country.

DESCRIPTION OF THE CONSIGNMENT

Name and Address of Exporter Continental Grain (S) Pte Ltd 10 Collyer Quay #07-09 Ocean Building Singapore 0104	Name and Address of Consignee Continental Grain Company 277 Park Avenue New York, N.Y. 10172
Number and Description of Packages 240,000 bags	Distinguishing Marks NIL
Quantity and Name of Produce Rice 12,000 tonnes	

Place of Origin Pakistan	Name of Conveyance MV	Point of Entry Sierra Leone
Botanical Name (if required by importing country)		Date of Shipment 4.7.91

DISINFESTATION AND/OR DISINFECTION TREATMENT

Date: Treatment:

Chemical: Concentration:

Duration and Temperature

ADDITIONAL DECLARATION

Signature

LIOW CHIN CHOG
Name of Authorised Officer

6 Sep 91
Date of Issue

No liability shall attach to the Primary Production Department or to any officer or representative of the Department with respect to this Certificate
IT SHALL BE UNLAWFUL FOR ANY PERSON TO ALTER DEFACE OR WRONGFULLY USE THIS CERTIFICATE

AUSTRALIA

SENATOR THE HON. GARETH EVANS Q.C.

MINISTER FOR FOREIGN AFFAIRS AND TRADE
PARLIAMENT HOUSE
CANBERRA A.C.T. 2600

CUSTOMS (PROHIBITED EXPORTS) REGULATIONS
PERMISSION TO EXPORT

Permission No: 2

I, GARETH EVANS, Minister of State for Foreign Affairs and Trade, pursuant to Regulation 13CA of the Customs (Prohibited Exports) Regulations, hereby give permission to the Australian Wheat Board for the export from Australia to Iraq of the goods specified in Part 1 of the schedule hereto, subject to the conditions specified in Part 2 of the schedule hereto, for the reasons specified in Part 3 of the schedule hereto. This permission is Number 2 in a series of 18.

SCHEDULE - PART 1

Up to 65,000 tonnes of Australian Standard White Wheat to be supplied to the Grain Board of Iraq and for delivery to Aqaba Jordan, for road transport to Iraq. This shipment is part of a sale of 900,000 tonnes 10% more or less of wheat by the Australian Wheat Board to the Grain Board of Iraq, with shipments commencing in August 1991 and, with best endeavours, being completed on or about the end of 1991. The indicative specifications of the wheat are:

Test Weight (kg/hl)	78.0
Protein (N x 5.7 at 11% moisture)	9.5%
Moisture	12.0%
Foreign Material	1.0%

SCHEDULE - PART 2

This permission is granted upon the condition that the Australian Wheat Board shall notify the Department of Foreign Affairs and Trade of the name of the vessel which will carry the goods specified in Part 1 of this schedule before the exportation of the said goods.

SCHEDULE - PART 3

This permission is granted because the exportation from Australia to Iraq of the goods specified in Part 1 of this schedule does not infringe UN Security Council sanctions against Iraq.

Dated this 16th day of July 1991

GARETH EVANS
Minister of State for
Foreign Affairs and Trade

UN approval certificate

Appendix 14.8

03587/3

UNITED NATIONS NATIONS UNIES

SECURITY COUNCIL COMMITTEE ESTABLISHED BY RESOLUTION 661 (1990) CONCERNING THE SITUATION BETWEEN IRAQ AND KUWAIT

30 December 1991

Sir,

On behalf of the Security Council Committee established by resolution 661 (1990) concerning the situation between Iraq and Kuwait, I have the honour to acknowledge receipt of your letter dated 23 December 1991 stating that the shipments of wheat to Iraq, of which you notified the Committee in your letter dated 11 July 1991 and which were originally scheduled to take place by the end of December 1991, will now continue into 1992.

I have the honour to confirm that, according to paragraph 20 of Security Council resolution 687 (1991), the Committee has been duly notified of the shipment of foodstuffs specified in your letter and that prohibitions against the sale or supply of these shipments and financial transactions related thereto contained in resolution 661 (1990) are no longer applicable.

Further, I have the honour to suggest that your Government ensure that copies of this communication are provided to shipping companies for onward transmission to the captains of merchant vessels engaged in the shipment of the specified goods destined for Iraq.

Accept, Sir, the assurances of my highest consideration.

Abelardo Posso Serrano
Vice-Chairman
Security Council Committee established by resolution 661 (1990) concerning the

His Excellency
Mr. Peter Wilenski
Ambassador Extraordinary and Plenipotentiary
Permanent Representative of Australia
to the United Nations
Permanent Mission of Australia to the
United Nations
One Dag Hammarskjöld Plaza
885 Second Avenue, 16th Floor
New York, N.Y. 10017

Certificate of origin

Appendix 14.9

44-005

REPUBLIQUE DE GUINEE

MINISTERE DE L'INDUSTRIE
DU COMMERCE
ET ARTISANAT

Kamsar, le 30/3/93

D.G.C.E. / BUREAU KAMSAR

N° 039 / CO/DGCE /BK/1/3

CERTIFICAT OF ORIGIN

We, the undersigned, (Bureau du Commerce extérieur Kamsar)
Certify that the merchandise described below is a product of REPUBLIC OF GUINEA, West Africa -

1) DESCRIPTION OF GOODS : BOKE BAUXITE
2) VESSEL :
3) CROSS WEIGHT : 53388 metric tons Load N° 93057
4) EXPORTER : CBC
5) LOADING PORT : KAMSAR
6) CONSIGNEE : COMALCO
7) PORT OF DISCHARGE : SAN CIPRIAN

SIGNATURE AND STAMP

SURINTENDANT EXPED. / LABO-CHIMIE
ABDOULAYE "SHIPLO" DIALLO

CBG/SHIPPING SUPERINTENDENT

BUREAU COMMERCE EXTERIEUR / KAMSAR

Australian
Coal
Association

BULK COAL CARGOES

DECLARATION BY SHIPPER

For the guidance of ships' masters in their application of the IMO Code of Safe Practice for Solid Bulk Cargoes

To the Master,

Vessel Name: [redacted]
Port of Loading: NEWCASTLE N.S.W
Commodity to be Shipped: WARKWORTH SEMI SOFT COKING COAL
Port(s) of Discharge: JAPANESE PORT(S)

CARGO CHARACTERISTICS

Transportable Moisture Limit

- [✓] This commodity is not considered a cargo which may liquefy during the voyage.

OR

- [ ] This commodity may liquefy. The Transportable Moisture Limit is .... %
The average moisture content of this cargo is .... %

Estimated Stowage Factor
..........(Cubic metres/tonne) 41 (Cubic Feet/ton)

Contractual Sizing
50mm x 0

Contractual Sulphur Content
.5% Percent

Special Precautions (Refer to the reverse side of this form)

- [ ] This cargo may be liable to emit significant amounts of methane

OR

- [✓] This cargo is not considered liable to emit significant amounts of methane
- [ ] This cargo may be liable to spontaneous combustion

OR

- [✓] This cargo is considered not liable to spontaneous combustion

EMERGENCY PROCEDURES

For detailed procedures and special precautions, the Master should refer to the entry for Coal (IMO 010) of Appendix B of the IMO Code of Safe Practice for Solid Bulk Cargoes, an extract of which is reproduced on the reverse of this form.

It is certified that for the bulk coal cargo nominated on this certificate, reasonable care has been taken to ensure the relevant information attendant upon its marine transportation has been properly described and that the information given is based upon the latest available experience.

SHIPPING AGENCIES PTY LIMITED NEWCASTLE N.S.W. AS AGENTS

Signature ....
By or on behalf of Master acknowledging receipt of the information

Signature ....
By or on behalf of WARKWORTH COAL SALES LIMITED
(Consignor)

Date 3-4-92

MASTER'S RESPONSE SHEET

GENERAL REQUIREMENTS SECTION 3-12/COAL ENTRY, B C CODE)

Vessel Name: __________ Date of Loading __________
Loadport: __________ Aprox. Tonnage: __________
Shipper: __________ Terminal: __________
Type/Name of Coal:

Cargo Specification Given on Shipper's Declaration

Moisture: __________
Sulfur: __________
Size: __________

Additional Information Given on Shipper's Declaration

Special Precautions Indicated by Shipper: [ ] **Coals Emitting Methane** [ ] **Self-Heating Coals**

If behaviour of Coal has differed from above, note below and return to contact address given on Shipper's Declaration.

Commentary on Behavior of Coal During Voyage:

Date: __________ Master' Signature: __________

CANADA

PORT WARDEN REPORT
CERTIFICATE OF READINESS TO LOAD

RAPPORT DU GARDIEN DE PORT
CERTIFICAT DE NAVIRE PRÊT À CHARGER

MV – N.M. [redacted]	P.R. – P.I. [redacted]	
PORT OF ISSUE – PORT DE DÉLIVRANCE: SEPT-ILES	DATE: Nov 17th 91	TIME – HEURE: 16:25

CARGO SPACE / ESPACE À CARGAISON	PARTICULARS OF CARGO, MANNER OF STOWAGE AND SECURING / DÉTAILS RELATIFS À LA CARGAISON, MÉTHODE D'ARRIMAGE ET D'ASSUJETTISSEMENT
	To be loaded, stowed and trimmed in accordance with the Code of Safe Practice For Solid Bulk Cargoes - Vessel to be loaded with appr. 59000 mT of iron ore concentrate as per attached stowage plan and loading sequence. - Not to be loaded beyond winter load line - Stresses must remain within limits at all time.

I HEREBY CERTIFY THAT THE ABOVE CARGO SPACES WHEREIN IT IS INTENDED TO LOAD ~~GRAIN~~*, CONCENTRATES* OR ~~A DECK CARGO OF TIMBER*~~ HAVE BEEN INSPECTED AND THAT THE REQUIREMENTS OF THE APPROPRIATE REGULATIONS OR APPROVED PRACTICE HAVE BEEN COMPLIED WITH.

LE SOUSSIGNÉ ATTESTE PAR LES AIRES DESTINÉES À RECEVOIR DES ~~GRAINS~~*, DES CONCENTRÉS*, OU ~~DU BOIS EN PONTÉE~~*, ONT ÉTÉ INSPECTÉES ET QU'ELLES SONT CONFORMES AUX EXIGENCES DU RÈGLEMENT PERTINENT OU À LA PRATIQUE APPROUVÉE

*(DELETE AS APPROPRIATE – BIFFER SELON LE CAS)

ISSUED CONDITIONALLY UPON THE METACENTRIC HEIGHT BEING MAINTAINED AT NOT LESS THAN / DÉLIVRÉ SOUS RÉSERVE QUE LA HAUTEUR MÉTACENTRIQUE SOIT GARDÉE À AU MOINS	— ft./ins./cm. – pi./po./cm.	SIGNATURE OF PORT WARDEN / SIGNATURE DU GARDIEN DE PORT

SECURITE DES NAVIRES / SHIP SAFETY / DEPARTMENT OF TRANSPORT / MINISTERE DES TRANSPORTS

82-0522 (05-90)

Canadian Coast Guard / Garde côtière canadienne

DISTRIBUTION 1. SHIP'S COPY – COPIE DU NAVIRE 2. DOCK COPY – COPIE DU PORT 3. AGENT'S COPY – COPIE DE L'AGENT 4. FILE COPY – COPIE POUR LE DOSSIER

Canada

Cert. of fitness to proceed to sea **Appendix 14.12**

Empire Shipping — Call Sign 3EBW4

CANADA

CERTIFICATE OF FITNESS TO PROCEED TO SEA / CERTIFICAT D'APTITUDE À PRENDRE LA MER

~~GRAIN~~ CONCENTRATES OR A DECK CARGO OF TIMBER / GRAINS CONCENTRES OU D'UNE PONTEE DE BOIS

MV – N.M.: Virginia	P.R. – P.I.: Panama	
PORT OF ISSUE – PORT DE DÉLIVRANCE: New Westminster, B.C.	DATE: June 16, 1993	TIME – HEURE: 15:00 P.M

ISSUED PURSUANT TO THE CANADA SHIPPING ACT FOR A SHIP WHOLLY OR PARTLY LOADED WITH GRAIN*, CONCENTRATES* OR A DECK CARGO OF TIMBER* *(DELETE AS APPROPRIATE)

DÉLIVRÉ EN VERTU DE LA LOI SUR LA MARINE MARCHANDE DU CANADA À UN NAVIRE TOTALEMENT OU PARTIELLEMENT CHARGÉE DE GRAINS*, DE CONCENTRÉS* OU D'UNE PONTÉE DE BOIS*. *(BIFFER SELON LE CAS)

CARGO SPACE / ESPACE À CARGAISON	PARTICULARS OF CARGO, MANNER OF STOWAGE AND SECURING / DETAILS RELATIFS À LA CARGAISON, MÉTHODE D'ARRIMAGE ET D'ASSUJETTISSEMENT
All Hatches on Deck.	3491 M. Tons of log timber loaded on board deck compactly stowed and secured with 19 m.m. dia. chains spaced at 3 meters, wiggle wire, etc. Catwalk from accommodation to Focsle and access for pilot provided.

CONCENTRATES / CONCENTRÉS	F.M.P. / P.D.A.	T.M.L. / L.E.H.T.	M.C. / T.E.H.
DRAFTS / TIRANT D'EAU — FORWARD / AVANT	9.65 meters		
AFT / ARRIÈRE	10.2 "		
MIDSHIP / MILIEU	9.925 "		
FREE BOARD / FRANC-BORD			
WATER DENSITY / DENSITÉ DE L'EAU	1.0165		
F.W.A. / A.E.D.			
SEASONAL DRAFT / TIRANT D'EAU SAISONNER — S. / E.; W. / H.; WNA / HAN; L.S. / B.E.; L.W. / B.H.; LWNA / BHAN			G.M. – H.M.: 68 Cms.

OPTIONAL INFORMATION WHICH MAY BE NOTED BY THE PORT WARDEN / RENSEIGNEMENTS QUI PEUVENT ÊTRE NOTÉS PAR LE GARDIEN DE PORT	
TOTAL CARGO LOADED THIS PORT / TOTAL CARGAISON CHARGÉE AU PORT	3491 M. Tons.
OTHER CARGO ON BOARD / AUTRE CARGAISON À BORD	Logs Under Deck ~~20H~~ 14873. ~~on deck 5599~~
FUEL OIL / MAZOUT	969.18 Tons.
	Diesel 78.81
FRESH WATER / EAU DOUCE	164 Tons.
BALLAST / LEST	2300 Tons.
CONSTANT / CONSTANTE	121
OTHER / AUTRE	
TOTAL DEADWEIGHT / TOTAL PORT EN LOURD	27590.99 Tons.

I HEREBY CERTIFY THAT INSOFAR AS THE STOWAGE OF THE CARGO IN THE ABOVE VESSEL CONFORMS WITH THE APPROPRIATE REGULATIONS OR APPROVED PRACTICE, THE VESSEL IS FIT TO PROCEED TO SEA.

LE SOUSSIGNÉ ATTESTE PAR LES PRÉSENTES QUE LE NAVIRE EST APTE À PRENDRE LA MER AU POINT DE VUE DE LA CONFORMITÉ DE L'ARRIMAGE DE SA CARGAISON AUX EXIGENCES DU RÈGLEMENT PERTINENT OU À LA PRATIQUE APPROUVÉE.

THIS IS NOT A CERTIFICATE OF SEAWORTHINESS

LES PRÉSENTES NE CONSTITUENT PAS UN CERTIFICAT DE NAVIGABILITÉ

BUT MAY BE USED TO OBTAIN A CLEARANCE TO: / MAIS PEUT ÊTRE UTILISÉ POUR OBTENIR UN CONGÉ À: Tomakomai, Japan

SIGNATURE OF PORT WARDEN – SIGNATURE DU GARDIEN DE PORT

Canadian Coast Guard / Garde côtière canadienne

82-0501 (04-90)

DISTRIBUTION 1. SHIP'S COPY – COPIE DU NAVIRE 2. CUSTOM COPY – COPIE DE LA DOUANE 3. DOCK COPY – COPIE DU PORT 4. FILE COPY – COPIE POUR LE DOSSIER

Canada

CERTIFICATE OF LOADING
(Bulk Grain Only)

— OF —

NATIONAL CARGO BUREAU, INC.

This is to Certify, *That the* [redacted] (Name of Vessel)

whereof [redacted] *Master, of* [redacted] *Net Tons, built at* ULSAN

in 19 67 *said to be bound for* TAIWAN

has been under the inspection of a surveyor or surveyors of NATIONAL CARGO BUREAU, INC. at this port from time to time during the course and in respect of the loading of grain in bulk; that so far as said cargo came under the observation of such surveyor or surveyors, the stowage was in accordance with the regulations of the Commandant, United States Coast Guard.

THIS CERTIFICATE IS NOT A CERTIFICATE OF SEAWORTHINESS AND RELATES ONLY TO THE ABOVE CARGO

THE FOREGOING INSPECTION WAS UNDERTAKEN AND THIS CERTIFICATE IS ISSUED ON THE FOLLOWING TERMS AND CONDITIONS:

While the Officers, Directors and Committees of National Cargo Bureau, Inc., use their best endeavors to see that the functions of the Bureau are properly executed, the Bureau makes no warranty of any kind, either express or implied, including warranty of workmanlike service, respecting its work or services, and is not an insurer of cargo or other property or of the ship or of the safety of any personnel and disclaims all legal responsibility for any loss, damage, personal injury or death resulting from any act, default, omission, negligence, error or breach of any said warranties, or from any wastage in bulk or weight or any other loss or damage arising from inherent defect, quality, or vice of the cargo. Neither the Bureau nor its Officers, Directors or Committee members nor its surveyors, employees, representatives or agents are under any circumstances whatsoever to be held responsible or legally liable for any inaccuracy or error in any report or certificate issued by the Bureau or by its surveyors or other agents or employees, or for any error of judgment, default, omission, negligence or breach of warranty, either express or implied, including warranty of workmanlike service, arising or allegedly arising out of services of the Bureau, its surveyors or other employees, representatives or agents. This certificate covers only the cargo herein described as having been loaded at place of issuance of this certificate, and under no conditions is it to be deemed to cover any other cargo whether loaded at place of issuance of this certificate, or any other port, nor to cover the maintenance, operation or supervision of the vessel or her personnel at any time. This certificate shall not be valid if upon sailing from any loading port and/or any fueling port and/or during any part of the voyage, the vessel's draft shall exceed that permitted by the law of her flag and/or the draft designated for the vessel in the Classification Society in which she may be classed.

Issued at PORTLAND, OREGON (Port)

2030 (Time) 2/22/92 (Date)

X ____________ (Master) ____________ (Surveyor)

A final Certificate of Loading will be issued in due course.

Rev. 1/82

Fumigation certificate ***Appendix 14.15***

FUMIGATION AND GÁS CERTIFICATE NO 040/88

THIS IS TO CERTIFY, in witness of aproval the terms requested and submitted by L.FIGUEIREDO S/A.-Administração Despachos Representações, registered in the Division of Vegetal Sanitary Defense of Agriculture ' Brasilia, under number 1212750005, hereby certify that in this Superintendence of Vegetal Sanitary Defense (PODEF) of the Ministry of Agriculture, S.Frco.doSul-State StªCatarina-Brazil, at 1130 hours on the 10 JULHO, 1.988, after duly inspected and convenient prepared, the holds nos. 1 / 2 / 3 / 4 / 5 / 6 / / / / / / /, of the vessel 'RUBENS' loaded with PELLETS IN BULK by several shippers, have been fumigated by the process of Methyl Bromid gas (CH3Br) and Chloropicrin 2% (two pct) in the dosage of 50 grames per cubic metre on the total cubic space of such holds during 72 hours of exposure ' and under the permanent supervision of Agronomist Engineers of this Superintendence of Vegetal Sanitary Defense (PODEF) of Ministry of Agriculture- São Francisco do Sul, SC.

Due to the necessity of vessel sailing, as it can not stay moored in port or at anchorage waiting for expiry of the period of the gas, and in accordance with the paragraf of article 8º Decree 675/60 issued by the Ministry of Agriculture, the Master of the above mentioned vessel hereby commits himself to make the exaustion during the voyage, after expiring 72 hours of exposure only, at 1130 hours on the 10 JULY OF 1.988.

Agronomist Engineer. Executive Principal of PODEF in São Francisco do Sul

POSTO DE EXPURGO L. FIGUEIREDO S. Reg. 37 VR 00 9 D. D. SAN. VEGETAL

In accordance ____________

M.V. RUBENS
PORT OF REG: HAMILTON
OFFICIAL No: 366308
GROSS TONNAGE: 17965.73
Master

2

Control Union

GESELLSCHAFT FÜR WARENKONTROLLE mbH & Co. KG
Sworn Cargo Superintendents and Samplers
Technical Inspections and Analysis

WEIGHT- AND QUALITY-
CERTIFICATE No. [redacted]

Contract:	Contract 5/85 Messrs. Andre & Cie. S.A. Lausanne, Switzerland
Parcel:	9.000.000 kgs. **YELLOW CORN**, in bulk Crop 1984/1985
Vessel:	M/V "[redacted]" - from Zadar to Tripoli
Sellers:	Messrs. Andre & Cie. S.A. Lausanne, Switzerland
Buyers:	The General National Company for Flour Mills and Tripoli/Libya

****

We, the undersigned **CONTROL UNION**, Gesellschaft für Warenko- P.O. Box 15 03 26, 2800 **BREMEN / W. GERMANY**, certify that b, of THE GENERAL NATIONAL COMPANY FOR FLOUR MILLS AND FODDER, carried out the control of weight quality and inspection of loading of a.m. parcel.

INSPECTION OF COMMODITY:

Inspection of the above mentioned parcel took place from July **27, 1985** until August 14, 1985.

SAMPLING:

Samples were drawn carefully mixed, sealed and analysed.

WEIGHING:

During our inspection the weight has been ascertained as 9.000 **metric tons.**

Control Union CERT. No. [redacted] page - 2 -

26

continued from page - 1 -

ANALYSIS:

Specifications of YELLOW CORN

Physical Specifications:

Sound loyal merchantable yellow corn. Free from alive and dead insects, of natural odor and free from fermentation. Free from poisonous seeds and weeds not lumpy or rotten. Not treated with chemicals harmful to animal and poultry consumption. Crop 1984/1985.

Analytical Specifications:

Moisture:	13.34 %
Protein:	9.18 %
Fat:	3.22 %
Fibre:	2.90 %
Ash:	1.22 %
Sound grains:	91.20 %
Broken grains:	7.60 %
Foreign materials:	1.2[illegible] %

INSPECTION OF VESSEL:

The M/V " KRPAN " was nominated to carry this parcel and arrived at loading berth in Zadar on July 22, 1985 at 17:20 hours.

Details of vessel were ascertained as follows :

Name:	" KRPAN "
Flag:	Yugoslavia
Built:	1966
G.R.T.:	9.080.89 tons
N.R.T.:	5.122.76 tons
Deadweight:	14.499 tons
De-rate Certificate:	issued at Sibenik/Yugoslavia on May 18, 1985.

We carried out one inspection of holds regarding cleanliness, dryness and foreign smell, presence of living insects and residues of previous cargo.

The vessel has in total 6 holds / no tweendecks which were found clean, dry, free from foreign smell, presence of living insects and residues of previous cargo.

As we had no objections, loading started accordingly..

Appendix 14.16(3)

Control Union CERT. No. [redacted] page 3

continued from page - 2 -

LOADING OF VESSEL:

Loading commenced: July 27, 1985 at 11.00 hrs.
Loading completed: August 14, 1985 at 17.00 hrs.

This parcel was stowed as follows :

Hold 1	- YELLOW CORN, in bulk	297.745 kos.
Hold 2.	- YELLOW CORN, in bulk	2.116.541 kos.
Hold 3	- YELLOW CORN, in bulk	1.438.950 kos.
Hold 4		e m p t y
Hold 5	- YELLOW CORN, in bulk	2.650.125 kos.
Hold 6	- YELLOW CORN, in bulk	2.496.639 kos.
		9.000.000 kos.

B/L-DETAILS:

The B/L (Bill of Lading) for this parcel was issued as follows:

B/L - No. 1: dated August 13, 1985
Vessel sailed: August 14, 1985 at 20.00 hours.
For Destination: Tripoli / Libya
Expected time of arrival: August 18, 1985

Bremen, August 22, 1985

CONTROL UNION
Gesellschaft für Warenkontrolle mbH & Co. KG

CONTROL-UNION 28 Bremen 1

This certificate does not release the parties concerned from their own contractual

Stowage plan (produced by ship's staff)

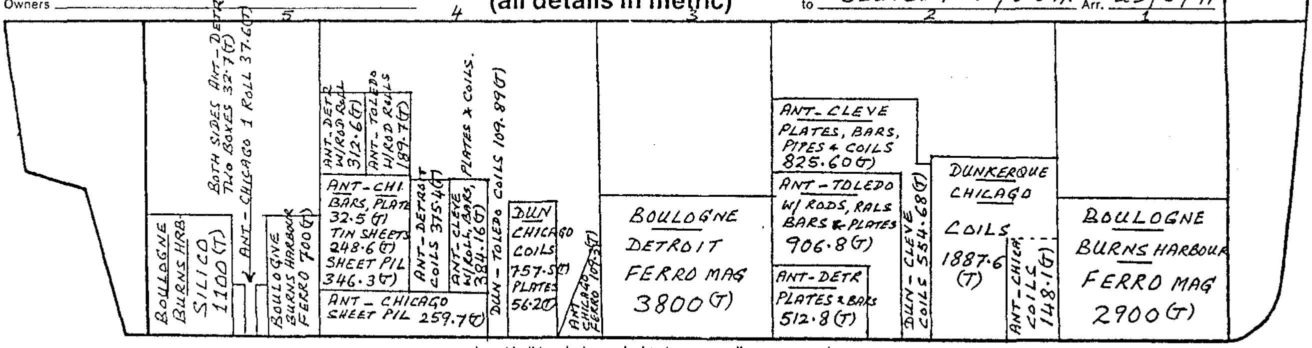
Appendix 14.17

13. Juni 1991

Stowageplan
(all details in metric)

MV. REGINA OLDENDORFF
Owners EGON OLDENDORFF

from DUNKERQUE Dep. 10/5/91
voyage to CLEVELAND / U.S.A. Arr. 23/5/91



Insert bulkheads, tweendecks etc. as per vsl's arrangements

Cargo
Commodity:
Distribution:

Hold	weight	Stow.factor	%
NO 1	2900.0		16.58
NO 2	4812.585		27.52
NO 3	3800.0		21.73
NO 4	4104.58		23.47
NO 5	1870.30		10.70
Total ship figures	17487.465 MT		100
Total shore figures	17487.465 MT		
Diff. shore/ship			
Stability	MG 4.25 m.		

Summary

	Departure	Arrival
Cargo (b/l)	17487.465	17487.465
HFO	667.37	314.80
Diesel	118.91	86.80
Freshwater	100.0	130.00
Constant (incl. Stores) 306	300.0	300.00
Ballastwater	NIL	NIL
DW	18673.75 MT	18319.065
Draft M (MID) F	7.69 M	7.85 M
Draft M	7.77 M	7.88 M
A	7.785 M	7.87 M
Trim	0.095 M	0.02 M
Sag/Hog	3.2 cm	2 cm
List	NIL	NIL
Density	1.025	1.000

19/6.91 f.c.

Used Tanks (compartment and contents)

HFO	1 FOT = 200.6, 3 FOT = 145.2, 4 FOT = 241.5 SETT (P) = 15.4, SETT (S) = 15.9 SERV = 19.3
Diesel	DO (P) = 53.8 DO (S) = 51.20 SETT = 7.4 SERV = 6.40
Freshwater	NO 1 (P) = 50, NO 1 (S) = 50
Ballastwater	NIL

Remarks (i. e. draft restr. etc): GREAT LAKES RESTRICTED DRAFT 26 FT (FW)

CLEVELAND / U.S.A.	23RD MAY 1991		
Place	Date	Master	Chief Mate

(To be submitted from first disch.port.)

Stowage plan (produced by shore staff)

STOWAGE PLAN

M.V. " R U B E N S " - VOY. 1-1734

SAILED FROM S.F.S. ON JULY 10th, 1988.

LOADED: 24.530.000 KGS BRAZILIAN SOYA BEAN MEAL PELLETS IN BUL

SHIPPER: CEVAL AGRO INDUSTRIAL S/A.

DESTINATION: "ANY IRANIAN SOUTHERN PORTS"

ARRIVAL DRAFT: FWD 03,98 Mts AFT 05,72 Mts

SAILING DRAFT: FWD 09,46 Mts AFT 09,63 Mts

Agência Marítima CARGONAVE Ltda.

HOLD	CUBIC FEET	STOWAGE FACTOR
1	151.497	55.3
2	198.483	51.9
3	261.167	52.3
4	203.281	54.0
5	260.810	52.8
6	225.064	52.5

6	5	4	3	2	1
4.281.765 KGS SEMPELLETS, IN BULK. FULL.	4.938.505 KGS SEMPELLETS, IN BULK. FULL.	3.750.655 KGS SEMPELLETS, IN BULK. FULL.	4.990.245 KGS SEMPELLETS, IN BULK. FULL.	3.824.335 KGS SEMPELLETS, IN BULK. FULL.	2.735.495 KGS SEMPELLETS, IN BULK. FULL.

Stowage plan (showing cargo separations)

OCT 1 1991

M/V ERIKSVANN VOYAGE 17

CHARTERER WEYERHAEUSER CO
SUB-CHARTERER
AGENTS SUNRISE SHIPPING
STEVEFORES TWIN HARBOR-SSA
CAPTAIN A.R. TINSLEY
CHIEF OFFICER S.E. GINER
SUPERCARGO GENE EVERSON

ARRIVED AT ABERDEEN 9-22-91 AT 1240 HRS
COMM LOADING 9-23-91 AT 0800 HRS
COMPLETE LOAD 9-27-91 AT 0930 HRS
FIRST LOG 9-23-91 1100
LAST LOG 9-27-91 0910
FINISH LASHING 9-27-91 1400
SAILED FOR NAOETSU, JAPAN
ON 9-28-91 AT 1300 HRS

DISCH PORT	NO. 1	NO. 2	NO. 3	NO. 4	ON DECK	TOTAL FBM	PIECES
NAOETSU-KOB					724540	724,540	4685
NAOETSU-C.I.					484,650	484,650	2531
NAOETSU-C.I.	38,890	94 350	98 000	90270		321 510	2570
NANAO-HAY	216 140	290,000	275 390	277 000		1,058,530	9653
TSURUGA-KOB	234 160	224,910	210,070	340000		1,009,140	3765
TOTALS	489,190	609 260	583,460	707,270	1209190	3,598,370	23204

ON DECK 1 209 190 SCRIB. 5832 TONS 7,216 PIECES
BELOW DECK 2389,180 SCRIB. 11 470 TONS 15988 PIECES
TOTAL CARGO 3,598,370 SCRIB. 17 302 TONS 23 204 PIECES
STOW FACTOR 441.1 WEIGHT FACTOR 4.8

BY DRFT CHECK NAOETSU DK. CARGO - 5900 M/T

SSA

CARGO RATIO DECK/HOLD
WEIGHT 50.8%
VOLUME 50.6%
487,315 CF

NAOETSU-KOB L-10A 860 Pcs FIR 108,360 FBM
L-9 419 Pcs SS 2 FIR 143,780 FBM B/OFF
L-13 A/B 1269 Pcs SC 6 HEM 150,730 FBM
NAOETSU-C.I. — PURPLE — ROPE — — L-12 967 Pcs SL 3 HEM 114,550 FBM B/OFF
L-11 879 Pcs SL FIR 109,180 FBM B/OFF
L-18 497 Pcs SC6 FIR 63,720 FBM B/OFF
— GREEN — — — PURPLE — — ROPE — —
L-19 600 Pcs IS 25 FIR 193 730 FBM B/OFF
L-8 291 Pcs RS 1 FIR 97,940 FBM B/OFF
— PURPLE — — — ROPE — — PURPLE — ROPE — — PURPLE —
L-14 300 Pcs SS2 FIR 97 870 FBM B/OFF
L-17A 1134 Pcs SC 6 FIR 129,330 FBM

	4	3	2	1
SAILING CONDITIONS FUEL IFO 1157 M/T MDO 120 FWATER 419 CONSTANTS 200 BALLAST 2921 CARGO 17302 TOTAL 22119 M/T DECK HEIGHTS 1. 7.02 m 2. 7.62 m 3. 7.67 m 4. 7.66 m 1053 824 CF	NAOETSU-C.I. L-15 A/B 702 Pcs SL 3 FIR 90,270 FBM — — GREEN — — NANAO-HAY L-7 A/B 2543 Pcs SC 6 FIR 277,000 FBM — — WHITE — — — ROPE — — ORANGE TSURUGA-KOB L-4 447 Pcs GC $15 FIR 164,000 FBM B/OFF L-2 535 Pcs SS 2 FIR 176,000 FBM B/OFF	NAOETSU-C.I. L-15 A/B 762 Pcs SL 3 FIR 98,000 FBM — — GREEN — — NANAO-HAY L-7 A/B 2543 Pcs SC 6 FIR 275,390 FBM — — — WHITE — — ROPE — — — TSURUGA-KOB L-4 344 Pcs GC $15 FIR 126,350 FBM B/OFF L-2 254 Pcs SS 2 FIR 83 720 FBM B/OFF	NAOETSU-C.I. L-17 196 Pcs SC6 FIR 22,350 FBM — — — PURPLE — — — L-16 591 Pcs SL 3 FIR 72 000 FBM B/OFF — — — — GREEN — — — — NANAO-HAY L-7 A/B 2692 Pcs SC 6 FIR 290,000 FBM — — — WHITE — — ROPE — — — TSURUGA-KOB L-4 370 Pcs GC $15 FIR 136 000 FBM B/OFF L-5 715 Pcs SC 6 FIR 88,910 FBM	NAOETSU-C.I. L-16 319 Pcs SL 3 FIR B/OFF 38,890 FBM — — — GREEN — — — — NANAO-HAY L-6 A/B 1875 Pcs SL 3 FIR 216,140 FBM — — — ORANGE — ROPE — — — L-3 A/B 640 Pcs SL 3 FIR 77,830 FBM L-1 460 Pcs RS 1 FIR 156,330 FBM B/OFF
CUBIC SPACE PER HOLD:	276 841 CF	275 757 CF	275 635 CF	225 591 CF

SAILING DRAFT FWD 9.49 AFT 9.60 MEAN 9.545 GM 72 GoM 40 ROLL PERIOD 23 SECONDS

FORM 283813 1/90 Printing Service TP-1 Tacoma

DENSITY - 1008 = 9.395W - 27870 D/PLACE
5800 LT SHIP
22070 KT

gencia Maritima CARGONAVE Ltda.

M A N I F E S T

NATIONALITY	NAME OF SHIP	VOY.No.	NET TONS	MASTER NAME	FROM	TO	SHEET
BRITISH	RUBENS	JULY	11236	WILLIAMS STEPHEN	SAO FRANCISCO DO SUL	ONE PORT OUT OF BANDAR CHAH BAHAR, BANADAR ABBAS IN CHARTERERS OPTION	1

B/L No.	SHIPPER	CONSIGNEE	MARKS AND NUMBERS	CONTENTS	GROSS/WEIGHT KILOS	FREIGHT
1	CEVAL AGRO INDUSTRIAL S.A.	TO THE ORDER OF BANK SEPAH TEHRAN IRAN.	IN BULK	BRAZILIAN SOYA BEAN MEAL PELLETS IN BULK	24530000	PAYABLE AS PER CHARTER PARTY
				TOTAL	24530000	

SAO FRANCISCO DO SUL , JULY 09TH

AGENCIA MARITIMA CARGONAVE LTDA

PACIFIC SHIPPING SERVICES, INC.

TO: United States Coast Guard
Long Beach / Los Angeles

Date: 05-06-92

In compliance with section 148.02-1 USCG Regulations, we provide the following in reference to the cargo being loaded for shipment aboard the M/V [redacted] Official #
Nationality:

1) Petroleum coke, uncalcined ORM-C
2) Approx. Metric Tons
3) Shipper: Applied Industrial Materials Corp.
100 First Stamford Place
Stamford, CT. 06904-2388 (24HR) 310 436-5235

This is to certify that the above named hazardous material is properly named, prepared, and otherwise in proper condition for bulk shipment by vessel in accordance with the applicable regulations of the U.S. Coast Guard.

DANGEROUS CARGO MANIFEST

PETROLEUM COKE, UNCALCINED ORM-C

HOLD #	QUANTITY
	METRIC TONS
2	8600 METRIC TONS
3	8700 METRIC TONS
	METRIC TONS
5	8800 METRIC TONS
6	8570 METRIC TONS
	METRIC TONS
TOTAL ON BOARD:	METRIC TONS

For AIMCOR
Pacific Shipping Services, inc.

Master M/V

200 Oceangate, Suite 530, Long Beach, California 90802
PH (310) 436-6221 FAX (310) 436-4433 TLX 140424

Material safety data

Appendix 14.22

0730E

MATERIAL SAFETY DATA SHEET

MSDS # 3013

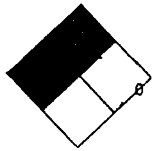
TOSCO CORPORATION
10100 SANTA MONICA BLVD.
LOS ANGELES, CALIFORNIA 90067

24 HOUR EMERGENCY ASSISTANCE

TOSCO:
CHEMTREC: 800-424-9300

SECTION I — GENERAL INFORMATION

TRADE NAME AND SYNONYMS: Coke	MATERIAL HAZARD:
CHEMICAL NAME AND SYNONYMS: Coke	FIRE HAZARD — RED HEALTH HAZARD — BLUE REACTIVITY — YELLOW SPECIFIC HAZARD — WHITE
FORMULA: Carbon and hydrocarbons	HAZARD RATING 0 ——→ 4 LEAST EXTREME
CAS#: 64741-79-3	



SECTION II — HAZARDOUS INGREDIENTS

COMPONENTS	%	OCCUPATIONAL EXPOSURE LIMITS
Solid carbonaceous material resulting from high temperature treatment of petroleum fractions. It contains some hydrocarbons having a high carbon-to-hydrogen ratio.	100	10 mg/M3 TWA (Cal-OSHA PEL - 1981)

SECTION III — HEALTH HAZARD INFORMATION

Petroleum coke does not present any unusual health hazards. Skin painting studies conducted by the American Petroleum Institute have found no evidence of tumorigenic activity. A chronic inhalation study initiated in August, 1981 has to-date shown no adverse effects.

ROUTE OF EXPOSURE	EFFECTS OF OVEREXPOSURE
EYE CONTACT	Solid particles can cause physical eye irritation.
SKIN CONTACT	
INHALATION	Inhalation of dust may lead to respiratory irritation; observe nuisance dust PEL of 10 mg/M3.
INGESTION	
SKIN ABSORPTION	

SECTION IV — EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT:	Flush eyes with large amounts of low pressure water.
SKIN CONTACT:	Wash with soap and water.
INHALATION:	N.A.
INGESTION:	N.A.

15 001 (11-82)

TLV — THRESHOLD LIMIT VALUE
PEL — PERMISSIBLE EXPOSURE LIMIT
L.T. — LESS THAN
N.D. — NOT DETERMINED
mg/M³ — MILLIGRAMS/CUBIC METER
ppm — PARTS PER MILLION
G.T. — GREATER THAN
TWA — TIME WEIGHTED AVERAGE
C — CEILING
S — SKIN

Page 1 of a two-page document

Hatch sealing certificate

Appendix 14.23

COTECNA SERVIÇOS LTDA.
Rua Riachuelo, 121 - 9.° Andar - Conj. 93
11100 - Santos - SP - Brasil
Tel.: (0132) 34-2982
Tlx.: (013) 1608 COTV BR

S.F. do Sul.. 10 07.88.

To the
MASTER M/V [illegible]ENS
In Port S. F. do Sul - BRASIL

Dear Sirs:

This is to inform you that hatchs cover and manholes of the vessel have been sealed with nylon and plastic seal ' "COINS". As per figures below:

HOLD 1...9410999...STAR..................PORT..........................
MANHOLES...
HOLD 2...9723999...STAR..................PORT..........................
MANHOLES...
HOLD 3...[illegible]...STAR..................PORT..........................
MANHOLES...
HOLD 4...3038443...STAR..................PORT..........................
MANHOLES...
HOLD 5...9504009...STAR..................PORT..........................
MANHOLES...
HOLD 6. 6971776.

MASTER/CHIEF OFFICER

COTECNA SERVIÇOS LTDA.

AGÊNCIA MARÍTIMA **CARGONAVE** LTDA

SAO FRANCISCO DO SUL, JULY 1988

VESSEL	:	RUBENS
TYPE	:	SELF TRIMMING BULK CARRIER
OWNERS	:	BOLTON MARITIME MANAGEMENT
CHARTERERS	:	ISLAMIC REPUBLIC OF IRAN SHIPPING LINES
CARGO	:	BRAZILIAN SOYA BEAN MEAL PELLETS IN BULK
NEXT PORT	:	PARANAGUA
DESTINATION	:	ANY IRANIAN SOUTHERN PORTS

SHIPPERS	QUANTITY	COMMODITY	BERTH
CEVAL AGRO IND. S/A	24530000 KGS	SBMPELLETS	COCAR

STATEMENT OF FACTS

VESSEL ARRIVED AT PILOT STATION.............	WEDNESDAY	06TH	0742 HRS
PILOT ON BOARD..............................	WEDNESDAY	06TH	0742 HRS
DROPPED ANCHOR INNER PORT...................	WEDNESDAY	06TH	0912 HRS
NOTICE OF READINESS TENDERED................	WEDNESDAY	06TH	0912 HRS
FREE PRATIQUE GRANTED.......................	WEDNESDAY	06TH	1030 HRS
HOLDS CLEARED BY MINISTRY OF AGRICULTURE.....	WEDNESDAY	06TH	1030 HRS
NOTICE OF READINESS ACCEPTED................	WEDNESDAY	06TH	1145 HRS
VESSEL BERTHED AT COCAR TERMINAL............	WEDNESDAY	06TH	1530 HRS
COMMENCED LOADING...........................	WEDNESDAY	06TH	1925 HRS
COMPLETED LOADING...........................	SUNDAY	10TH	1115 HRS
COMPLETED FUMIGATION........................	SUNDAY	10TH	1130 HRS
VESSEL SAILED FOR PARANAGUA.................	SUNDAY	10TH	1200 HRS

-*-*-*-*-*-*-*-*-*-

RAIN PERIODS :

THURSDAY 07TH - 1700/1955 HRS
SATURDAY 09TH - 1455/2030 - 2105/2400 HRS
SUNDAY 10TH - 0000/0600 HRS

-*-*-*-*-*-*-*-*-*-

DAILY LOADING REPORT

WEDNESDAY	06TH	1530/1925	WAITING THE LOADING OPERATION
		/1925	COMMENCING LOADING
		1925/2400	LOADING - TOTAL LOADED 3028.190 KGS
THURSDAY	07TH	0000/1700	LOADING
		1700/1955	RAIN
		1955/2400	LOADING - TOTAL LOADED 10492.915 KGS
FRIDAY	08TH	0000/1700	LOADING
		1700/1900	NO WORKED - MEAL TIME
		1900/2400	LOADING - TOTAL LOADED 9080.830 KGS
SATURDAY	09TH	0000/0400	LOADING
		0400/0700	NO WORKED SHIFTING GANG
		0700/1130	LOADING
		1130/1255	TRIMMING CARGO
		1255/1350	LOADING
		1350/1445	TRIMMING CARGO
		1455/2030	RAIN
		2030/2105	TRIMMING CARGO
		2105/2400	RAIN - TOTAL LOADED 1655.150 KGS

M.V. RUBENS
PORT OF REG: HAMILTON
OFFICIAL No: 366308
GROSS TONNAGE: 17965.73
NETT TONNAGE: 11236.17

PARANAGUÁ - SÃO FRANCISCO DO SUL

AGÊNCIA MARÍTIMA **CARGONAVE** LTDA

SUNDAY	10TH	0000/0600	RAIN
		0600/0700	SHIFTING GANG
		0700/1115	LOADING
		/1115	COMPLETED LOADING: TOTAL LOADED: 242.915 KGS

-*-*-*-*-*-*-*-*-*-

BUNKERS ON ARRIVAL	F.O. 292 MT	D.O. 51 MT	FWATER 80 MT
BUNKERS ON SAILING	F.O. 292 MT	D.O. 42 MT	FWATER 50 MT

DRAFT ON ARRIVAL :	FWD 03,98 MTS	AFT 05,72 MTS
DRAFT ON SAILING :	FWD 09,46 MTS	AFT 09,63 MTS

-*-*-*-*-*-*-*-*-*-

MASTER M/V RUBENS

AGENCIA MARITIMA CARGONAVE LTDA.
AS AGENTS

M.V. RUBENS
PORT OF REG: HAMILTON
OFFICIAL No: 366308
GROSS TONNAGE: 17965.73
NETT TONNAGE: 11236.17

Agência Marítima Laurits Lachmann S. A.
SÃO FRANCISCO DO SUL - SC

AGENCIA MARITIMA L. LACHMANN S.A

SUBJECT TO ALL TERMS CONDITIONS OF GOVERNING CHARTER PARTY

PARANAGUÁ - SÃO FRANCISCO DO SUL

Speciman letter of protest — *Appendix 14.25*

Fig. 14.ACC

Specimen Letter of Protest

mv.................
at.................
Date...............

To (Receivers)

Dear Sirs

Alleged Stoppages due to Crane Breakdown

I refer to the attached "Stoppage due to crane breakdown" sheet. This document, dated 17.8.88, refers to stoppages of ship's cranes Nos. 3 & 5 at hatches 4 & 6 on 17.8.88 from 0700 to 0930 hrs.

During this period, which occurred at the commencement of discharge, the cranes were being adjusted for height of travel, and the crane hooks and associated linkages were being removed. This was found to be necessary to compensate for the fact that the hoppers on the quayside, into which the cranes were required to discharge, were so high that the grabs could not enter them while the cranes were rigged in the normal manner.

In other words, the cranes had to be adjusted to suit the equipment on the quayside, and this took 2 5 hours.

If we had been warned whilst at anchor of the height of the hoppers we could have made these adjustments before berthing, and no time would have been lost on berthing.

I must inform you that neither my vessel nor owners can accept any responsibility for the delays incurred due to this matter, as the cranes in question were in normal working condition at all times during the period in question

Yours faithfully

Master

Speciman empty hold certificate — *Appendix 14.26*

Fig. 14.ADD

Specimen Empty Hold Certificate

Port...............
Date...............

To the Master

mv..............(Own vessel)

Dear Sir

Empty Hold Certificate

I hereby confirm that holds Nos...................... have been completely discharged, and that no further cargo remains in them.

Yours faithfully

for the discharging stevedores.

Trimming certificate

To the Master / ~~Ist Officier~~

S/S : —

Destination : Kenya

Commodity : Ece Milling wheat in Bulk – empty bags –

I being, Master / ~~Ist Officier~~ of the above mentioned vessel hereby agree that the trimming on the hold / Tween deck n° 1·2·3·4·5. has been made to my satisfaction.

Hold n°	1	2	3	4	5	6	7	8	9	Total
Tonnage	2538ᵀ 56 Full	5026ᵀ 155 Full	1857ᵀ 000 Full	4970ᵀ 330 Full	2718ᵀ 405 Full					17510ᵀ 355 (Wheat)
Tween deck	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
Tonnage			42ᵀ 000 Empty Bags / 399ᵀ 910 Wheat in Bulk							254ᵀ 300 (Bags)

⊕ 1 Palette n° 178.

Rouen, date : The 08 th on November 1992

Signature : Master

PIRAEUS

CAPITAINES - EXPERTS
ROUEN

Clean ballast discharge permit

THE PORT OF LONG BEACH
TRADE CENTER FOR THE WORLD

CLEAN BALLAST DISCHARGE PERMIT

Permit No. 162-92 Issue Date May 1, 1992

Expiration Date May 1, 1993

REQUEST OF: Vessel M/V [redacted], and her master, owner, operator, charterer, or agent

REQUEST FOR: DISCHARGING CLEAN BALLAST WATER

AT: 212 LB ON: MAY 7, 1992

Date Commence-Terminate 1800/7 – 0300/11

DISCHARGE FROM: (Check One) SBT's X TYPE OF BALLAST: SEA WATER

CBT's X LOADING PORT:

OTHER (SPECIFY)

REQUESTED BY: Name: A. R. MADLEM, OPERATIONS MANAGER

Company: ~~GENERAL STEAMSHIP CORP., LTD~~ – As Agents

Address: 302 W 5TH STREET, SUITE 101 SAN PEDRO, CA. 90731

Phone No.: (310) 832-0314

Signature: ARMadlem

Pursuant to request of the above vessel, her master, owner, agent, or permittee, discharge of CLEAN BALLAST WATER TANKS into the waters of the Long Beach Harbor District is authorized upon the following conditions:

1. Violation of the pollution or ballast regulations, Tariff No. 4, Item 748 and all other applicable items; 33 CFR Part 157; and all other applicable federal, state, and local rules and regulations, shall result in a revocation of this permit.
2. Port Security must be notified at (213) 590-4185 of each intent to discharge clean ballast water 24 hours prior to the vessel's arrival.
3. *Ballast may be discharged from* ABOVE THE WATER LINE *with a visible* OUTFALL *or* BELOW THE WATER LINE. *In all* cases, an hourly check of discharge shall be made to ascertain the cleanliness thereof. Record of all checks and condition of discharge shall be kept during a vessel's stay in port and shall be posted at the gangway. The discharge location shall be designated by a bunting secured at the vessel's side at the main deck level directly over the discharge location, with sufficient illumination at night so that the water surface at the discharge point may be clearly seen. Where access is available, the master, prior to discharge of ballast, shall ensure that ballast is not discharged unless he finds that there is no oily mixture or other prohibited material after visually examining the top of the ballast contents of each tank or testing the ballast contents of each tank with an oil/water interfacedetector or other device. (Note: In certain situations Federal Regulations regarding tank vessels require constant visual monitoring.)
4. In the event that the discharged ballast water is not clean, and contains visible settleable solids, floating solids, oil sheen, or other visible residue, the vessel, her master, owners, charterers, operators managers, agents, or permittee shall immediately notify the Chief Wharfinger and desist from further discharge and at its or their cost, shall immediately remove or cause to be removed, such matter to the satisfaction of the Executive Director or designee, and if not immediately removed, the Executive Director or designee may cause the removal of such matter and invoice the parties mentioned above for the cost thereof, including interest at the maximum rate allowed by law from the date of the discharge, which shall be immediately due and payable. The enumerated parties shall also be liable as further set forth in Tariff No. 4, Item 748, copy of which is attached hereto and made a part hereof.

EXECUTIVE DIRECTOR
LONG BEACH HARBOR DEPARTMENT

MUST BE POSTED AT GANGWAY

Paint compliance certificate — Appendix 14.29

DJK RESEARCH CENTER INC.

DJK Ref. No. N9-0023

CERTIFICATION

DJK Research Center Inc., Testing Laboratory hereby certifies that the following product covered and manufactured by

NIPPON STEEL CHEMICAL CO., LTD., No. 13-16
Ginza 5-chome, Chuo-ku, Tokyo 104, Japan

complies with the specification outlined in Code of Federal Regulations (CFR), Title 21, Food and Drugs (By Food and Drug Administration, Department of Health and Human Services, USA), Section 175.300 (Resinous and Polymeric Coatings) and Section 177.1680 (Polyurethane Resins).

1. Uses: For Dry Solids

2. Product Covered: NB-COAT 3000GW

DJK Research Center Inc., Testing Laboratory certifies that a search was made under Code of Federal Regulations (CFR), Title 21, Parts 100-199 for NIPPON STEEL CHEMICAL CO., LTD., for the purpose of determining compliance of the above product under Section 175.300 "Resinous and Polymeric Coatings" and Section 177.1680 "Polyurethane Resins" for the safe use of such coating as an indirect food additive, and that said search revealed each component to be listed under Section 175.300 and 177.1680 for use as the food contact surface of articles intended for use under conditions prescribed in Section 175.300 and 177.1680.

Validity

This Certificate Report will be valid only for two(2) years after issuance of the Report. Any formulation change will forfeit validity of the Report.

Independent and third party

International Testing Laboratory

Date: July 29, 1990

Notice of readiness — Appendix 14.30

Bolton Maritime Management

To: Agencia Maritime Laurits Lachmann
Racre 30
P.O. Box 1629
20.081 Rio de Jineiro
Brazil

Name of Vessel: M.V. "RUBENS"
Port of Sao Francisco do Sul
6th July 1988

NOTICE OF READINESS

Dear Sirs,

Please be advised of the arrival of the above vessel at the port of Sao Francisco do Sul at ....0912......... hrs today the 6th July 1988.

The vessel is in all respects ready to commence LOADING a full cargo of 24530 M/T ,of SOYA BEAN MEAL PELLETS in Bulk.

Time to commence in accordance with the terms and conditions of the Governing Charter Party

Please acknowledge receipt of this Notice of Readiness by signing and returning duplicate copies herewith.

Yours very truly,

....

S.F. Williams Master

M.V. RUBENS
PORT OF REG: HAMILTON
OFFICIAL No: 366308
GROSS TONNAGE: 17965.73
NETT TONNAGE: 11236.17

Received By:
AGÊNCIA MARÍTIMA LAURITS LACHMANN S.A.
SÃO FRANCISCO DO SUL — S.C.
....

per: ....

Date and Hour ...JULY 06th., 1988 AT 11:45 HOURS.

SUBJECT TO ALL TERMS CONDITIONS AND OR EXCEPTIONS OF THE GOVERNING CHARTER PARTY.

United States Form

THE reference numbers within diamonds < > refer to the corresponding numbers marked in the appropriate places on the completed copy of the United States grain stability calculation form.

<17> The blank cargo plan on page 1 is hardly adequate to show the information required, especially for a Panamax vessel. A copy of one of the ship's plans, suitably completed, will probably be acceptable as an alternative.

<18> The intermediate section of Part II is to be completed if the arrival section shows ballast which is not listed in the departure section, because the worst condition will occur as ballasting commences. This is equally true for the time that bunkering commences, if bunkers are taken between the loading and discharging ports, so it is sensible to complete the intermediate section if the arrival section shows bunkers which were not listed in the departure section. The intermediate section of the completed form shows 3C and P & S DO tanks before bunkering, but with free surface effect.

<19> Half way down Part III A is as far as must be completed for ships with full conventional grain documentation.

NATIONAL CARGO BUREAU, INC.

GRAIN STABILITY CALCULATION

S.S/M.V. REGINA OLDENDORFF		YEAR BUILT 1982 AT DALIAN
COUNTRY OF REGISTRY HONG KONG	NET TONNAGE 10713	OFFICIAL NO. 8120703
AGENT		

GRAIN LOADING BOOKLET APPROVED BY LLOYD'S REGISTER

DRAWING NO. DL41443-050-006JS-1 DATE OF APPROVAL (PROVIS.) 6.5.86

APPLICABLE REGULATIONS

ADDENDUM FOR UNTRIMMED ENDS APPROVED BY

DRAWING NO. DATE OF APPROVAL

LOADING PORT THREE RIVERS, CANADA

BUNKERING PORTS CEUTA, SPANISH MOROCCO

DISCHARGE PORT ORAN, ALGERIA

STEAMING DISTANCE 3350 MILES PER DAY 348 TIME 9.6 DAYS

DAILY CONSUMPTION: FUEL 37 DIESEL 2 WATER ~~7~~ 10

	DISPLACEMENT	DEADWEIGHT	DRAFT	FREEBOARD
*WINTER				
SUMMER	36,082 mt	28,031 mt	10.238 m	3.112 m
*TROPICAL				

FRESH WATER ALLOWANCE 234 mm ~~TPI~~/TPC (AT SUMMER DRAFT) 38.6

* (If Applicable)

THIS IS TO CERTIFY THAT:

1. THIS CALCULATION IS PREPARED IN ACCORDANCE WITH THE REQUIREMENTS OF THE VESSEL'S GRAIN LOADING BOOKLET AND THE APPLICABLE GRAIN REGULATIONS;
2. THE STABILITY OF THE VESSEL WILL BE MAINTAINED THROUGHOUT THE VOYAGE IN ACCORDANCE WITH THIS CALCULATION.

CALCULATION PREPARED BY:
(TO BE COMPLETED IF FORM PREPARED BY OTHER THAN SHIP'S PERSONNEL)

NAME (PRINT)

COMPANY

SIGNATURE DATE

MASTER

EXAMINED:

N.C.B. SURVEYOR

DATE:

NOTE: ORIGINAL STABILITY CALCULATION AND GRAIN ARRANGEMENT PLAN TO BE SUMITTED TO THE N.C.B. SURVEYOR. ALL TONNAGES USED IN THESE CALCULATIONS SHALL BE SHOWN IN THE SAME UNITS AS USED IN THE GRAIN LOADING BOOKLET.

REV. 1/1/90

PART I

SHIP AND CARGO CALCULATION

TYPE OF GRAIN WHEAT STOWAGE FACTOR (S.F.) ________ CU.FT./L.T. 1.246 M^3/M.T. ________

COMPT. NO.	CARGO (1)	S.F. (1)	GRAIN CUBICS 100%	GRAIN CUBICS ACTUAL (2)	WEIGHT (3)	V.C.G.	MOMENT (3)
1 HOLD			6848.	6351.8	5305.8	8.36	44356
2 "			7866		6313	7.79	49178
3 "			5503.4	2858.3	2294	4.80	11011
4 "			8060.5		6469	7.79	50394
5 "			6699.1	6344.2	5169	8.11	41421

THIS CALCULATION IS PREPARED IN:

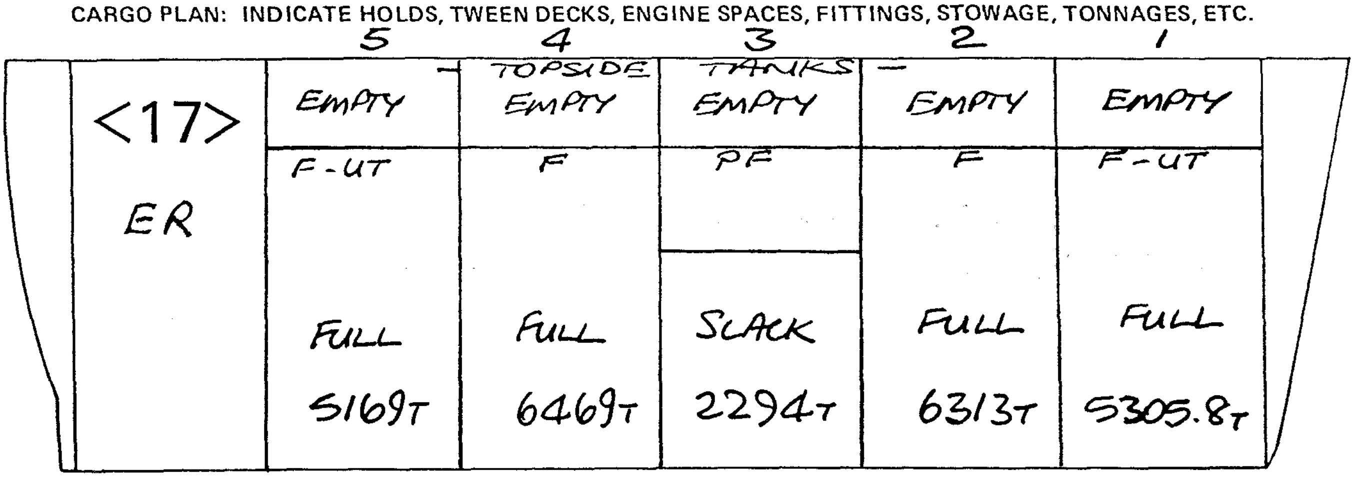
☐ ENGLISH UNITS
☑ METRIC UNITS

	WEIGHT	V.C.G.	MOMENT
CARGO TOTALS	25550.8		196360
LIGHT SHIP	8051	10.119	81468
STORES	372.1	8.49	3160.6
SHIP AND CARGO TOTALS	33973.9		280988.6

S.F. CuFt/LT	S.F. M^3/MT	DEN. MT/M^3
42	1.171	.854
42.5	1.184	.844
43	1.199	.834
43.5	1.212	.825
44	1.226	.815
44.5	1.240	.806
45	1.254	.797
45.5	1.268	.789
46	1.282	.780
46.5	1.296	.772
47	1.310	.763
47.5	1.324	.755
48	1.338	.748
48.5	1.352	.740
49	1.366	.732
49.5	1.380	.725
50	1.393	.718
50.5	1.407	.711
51	1.421	.704
51.5	1.435	.697
52	1.449	.690
53	1.477	.677
54	1.505	.664
55	1.533	.652
56	1.561	.641
57	1.589	.629
58	1.616	.619
59	1.644	.608
60	1.672	.598
61	1.700	.588
62	1.728	.579

COMPLETE THESE COLUMNS IF MORE THAN ONE TYPE CARGO IS LOADED.
(2) FOR PARTLY FILLED COMPARTMENTS, SHOW ACTUAL CUBIC OCCUPIED IN ADDITION TO FULL CUBIC.
(3) WEIGHTS AND MOMENTS SHOULD BE SHOWN TO THE NEAREST WHOLE UNIT.

CARGO PLAN: INDICATE HOLDS, TWEEN DECKS, ENGINE SPACES, FITTINGS, STOWAGE, TONNAGES, ETC.



PART II

FUEL AND WATER CALCULATION

INTERMEDIATE SECTION IS REQUIRED TO BE COMPLETED IF ARRIVAL SECTION SHOWS BALLAST WHICH IS NOT LISTED IN DEPARTURE SECTION. INTERMEDIATE CONDITION IS BEFORE BALLASTING SO IT INCLUDES THE EFFECT OF FREE SURFACE BUT NOT EFFECT OF WEIGHT OF THE BALLAST WHICH IS TO BE TAKEN ABOARD.

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		DEPARTURE: THREE RIVERS				INTERMEDIATE: ARR. CEUTA FOR BUNKERS				ARRIVAL: ORAN			
TANK	TYPE LIQUID	WEIGHT	V.C.G.	MOMENT	F.S. MOM.	WEIGHT	V.C.G.	MOMENT	F.S. MOM.	WEIGHT	V.C.G.	MOMENT	F.S. MOM.
3DBs	WB	490	1.04	509.6	36	490	1.04	509.6	36	490	1.04	509.6	36
4DBs	WB	860	1.40	1204	5	860	1.40	1204	5	860	1.40	1204	5
AP	WB	100	8.70	870	270	100	8.70	870	270	50	7.90	395	65
3c	FO	305	0.47	143.4	3042	11.5	0.02	0.2	3042	136.5	0.21	28.7	304.2
4c	FO	35.2	0.08	2.8	1546	1	0.00	0	-	1	0.00	0	-
SETS P+S	FO	24	11.10	266.4	51	24	11.10	266.4	51	24	11.10	266.4	51
SERV	FO	21	11.52	241.9	25	21	11.52	241.9	25	21	11.52	241.9	25
P	DO	18.1	0.41	738.4	80	9.1	0.25	2.3	63	46.6	0.85	39.6	118
[illegible]	DO	18.1	0.41	738.4	80	9.1	0.25	2.3	63	46.7	0.85	39.6	118
SET	DO	7.7	11.85	91.2	1	7.7	11.85	91.2	1	7.7	11.85	91.2	1
SERV	DO	8.5	12.00	102	1	8.5	12.00	102	1	8.5	12.00	102	1
1P	FW	47.0	12.44	584.7	138	32.0	12.2	390.4	115	19.0	12.0	228	100
2P	FW	31.0	12.69	393.4	24	25.0	12.5	312.5	20	20.0	12.4	248	15
2S	FW	31.0	12.69	393.4	24	25.0	12.5	312.5	20	20.0	12.4	248	15
DRW	FW	40.0	12.35	494	118	30.0	12.2	366	105	20.0	12.0	240	90
COOL W	FW	11.0	2.18	24	1	11.0	2.18	24	1	11.0	2.18	24	1
TOTALS LIQUIDS		2047.6		6797.6	5442	1664.9		4695.3	3818	1782		3906	3683
SHIP AND CARGO		33973.9		280988.6		33973.9		280988.6		33973.9		280988.6	
GRAND TOTALS DISPLACEMENT		36021.5		287786.2		35638.8		285683.9		35755.9		284894.6	

Departure		Intermediate		Arrival	
DEPARTURE KG	7.99	INTERMEDIATE KG	8.02	ARRIVAL KG	7.97
(1) FREE SURFACE CORR.(+)	0.15	(1) FREE SURFACE CORR.(+)	0.11	(1) FREE SURFACE CORR.(+)	0.10
(2) VERT. S.M. CORR. (+)	NA	(2) VERT. S.M. CORR. (+)	NA	(2) VERT. S.M. CORR. (+)	NA
KG_V	8.14	KG_V	8.13	KG_V	8.07
DEPARTURE KM	9.49	INTERMEDIATE KM	9.48	ARRIVAL KM	9.48
DEPARTURE KG_V	8.14	INTERMEDIATE KG_V	8.13	ARRIVAL KG_V	8.07
DEPARTURE GM	1.35	INTERMEDIATE GM	1.35	ARRIVAL GM	1.41
REQUIRED MINIMUM GM	0.30	REQUIRED MINIMUM GM	0.30	REQUIRED MINIMUM GM	0.30

NOTES

(1) FREE SURFACE CORR. = $\frac{\text{SUM OF FREE SURFACE INERTIA MOMENTS}}{\text{DISPLACEMENT}}$ (THIS CORRECTION MUST BE APPLIED TO ALL SHIPS.)

(2) VERT. S.M. CORR. = $\frac{\text{SUM OF VERTICAL SHIFTING MOMENTS FOR CARGO}}{\text{DISPLACEMENT}}$ (THIS CORRECTION APPLIES ONLY WHEN VERTICAL SHIFTING MOMENTS ARE PROVIDED IN THE SHIP'S GRAIN LOADING MANUAL.)

STABILITY SUMMARY

PART III

COMPT. NO.	STOW-AGE (1)	GRAIN DEPTH OR ULLAGE	VOLUMETRIC HEELING MOMENT	S.F. OR DENSITY (2)	GRAIN HEELING MOMENT	VERTICAL SHIFTING MOMENT SEE NOTE 2 PART II	
		FT/M	FT^4/M^4		L.T.-FT. M.T.-M.	FT^4/M^4	L.T.-FT. M.T.-M.
1	F-UT		1882	1.246			
2	F		535	1.246			
3	PF	D: 6.3M	8900	1.246			
4	F		547	1.246			
5	F-UT		2024	1.246			
		TOTALS	13888		11146		

(1) UNDER STOWAGE INDICATE "F" FOR FILLED COMPARTMENTS, "F-UT" FOR FILLED COMPARTMENTS UNTRIMMED, "PF" FOR PARTLY FILLED COMPARTMENTS, "SEC" FOR SECURED OR OVERSTOWED COMPARTMENTS.

(2) THE STOWAGE FACTOR USED IN PART III SHALL NOT EXCEED THE VOLUME PER UNIT WEIGHT (TEST WEIGHT) OF THE GRAIN. IF STOWAGE FACTOR IS SAME IN ALL COMPARTMENTS, DIVIDE TOTAL VOLUMETRIC HEELING MOMENT BY STOWAGE FACTOR OR MULTIPLY BY DENSITY TO OBTAIN GRAIN HEELING MOMENT. IF STOWAGE FACTOR VARIES, OBTAIN GRAIN HEELING MOMENT FOR EACH COMPARTMENT.

A. FOR VESSELS APPROVED UNDER
REGULATION 4, CHAPTER VI, SOLAS 1974 or ✓
REGULATION 4, IMCO RESOLUTION A.264(VIII), SOLAS 1960 or
REGULATION 4, IMCO RESOLUTION A.184(VI), SOLAS 1960

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	DEPARTURE	INTERMEDIATE	ARRIVAL
DISPLACEMENT	36021.5	35638.8	35755.9
KG_v	8.14	8.13	8.07
TOTAL GRAIN HEELING MOMENT	11146	11146	11146
MAXIMUM ALLOWABLE HEELING MOMENT	11595	11433	11981
*ANGLE OF HEEL (12° MAX.)			
*RESIDUAL AREA .075 METER-RADIANS, 14.1 FT° OR 4.3M° MIN.			
*GM (0.3M OR 1 FT. MIN.)			

*TO BE COMPLETED IF VESSEL'S GRAIN LOADING BOOKLET DOES NOT INCLUDE A TABLE OF ALLOWABLE HEELING MOMENTS. IN SUCH CASE, STATICAL STABILITY DIAGRAMS DEMONSTRATING THIS INFORMATION SHALL BE ATTACHED HERETO.

B. FOR SPECIALLY SUITABLE SHIPS APPROVED UNDER
SECTION V(B), PART B, CHAPTER VI, SOLAS 1974 or
SECTION V(B), PART B, IMCO RESOLUTION A.264(VIII)
REGULATION 12, CHAPTER VI, SOLAS 1960

$$\text{ANGLE OF HEEL} = \frac{\text{GRAIN HEELING MOMENT} \times 57.3}{\text{DISPLACEMENT} \times \text{GM}}$$

	DEPARTURE	INTERMEDIATE	ARRIVAL
TOTAL GRAIN HEELING MOMENT			
DISPLACEMENT			
GM (CORRECTED OF LIQUID FREE SURFACE)			
ANGLE OF HEEL (5° MAX.)			

VIRTUAL LOSS OF GM WHEN GROUNDING OR DOCKING

WHEN a vessel takes the ground in a berth, or takes the blocks in a floating or drydock, she experiences an upthrust at the point where she first makes contact. If the vessel is trimmed by the stern this point will be the sternpost. The effect of the uprthrust is to reduce the vessel's stability (i.e., to cause a virtual loss of GM). The value of the loss of stability is:

$$GG_1 = \frac{MCTC \times t \times KG}{d \times W - MCTC \times t}$$

where:

- GG_1 = virtual loss of GM. (metres)
- MCTC = moment to change trim 1 cm (tonnes. metres). The value used should correspond to mean draft when afloat.
- t = difference between trim when afloat and trim when aground (centimetres).
- KG = height of centre of gravity of ship above keel (metres).
- d = distance of centre of flotation from point at which vessel first touches (metres).
- W = weight (displacement) of ship (tonnes).

When a vessel is to take the blocks in a dock, or the ground in a berth, the above formula should be used to calculate the loss of GM which will occur during the critical period, which is the time between first touching and finally settling on the blocks or ground.

The loss of stability will be at a maximum immediately before the vessel takes the blocks, or the ground.

If the loss of GM is greater than the initial GM the vessel will become unstable, and will list, during the manoeuvre. This is completely unacceptable when docking, or when taking the ground, as the list cannot be controlled, and is likely to lead to damage to the ship, dock or berth.

This calculation must be repeated each time that the vessel takes the ground or refloats, using the calculated draft, trim, deadweight and GM for the condition of loading at that time. A part laden ship will usually be more stable than a fully laden one, as the centre of gravity of the cargo will be lower.

Any loss of stability will be minimised when the vessel is trimmed even keel, so a condition close to even keel should be the objective on each occasion that the vessel grounds or refloats.

MARITIME SAFETY CARD

Entering cargo spaces, tanks, pump-rooms, fuel tanks, cofferdams, duct keels, ballast tanks and similar enclosed compartments

GENERAL PRECAUTIONS

Do not enter an enclosed space unless authorized by the master or a responsible officer and only after all the appropriate safety checks listed overleaf have been carried out.

The atmosphere in any enclosed space may be incapable of supporting human life. It may be lacking in oxygen content or contain flammable or toxic gases. This also applies to tanks which have been inerted.

The master or a responsible officer should ensure that it is safe to enter an enclosed space by:

.1 ensuring that the space has been thoroughly ventilated by natural or mechanical means;

.2 testing the atmosphere of the space at different levels for oxygen deficiency and harmful vapour where suitable instruments are available; and

.3 requiring breathing apparatus to be worn by all persons entering the space where there is any doubt as to the adequacy of ventilation or testing before entry.

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 overleaf should be carried out before entry and breathing apparatus must be worn.

Protective equipment and clothing

It is important that all those entering an enclosed space wear suitable clothing and that they make use of protective equipment which 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 on 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 the ship – make sure that they are made known to all concerned.

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SAFETY CHECK LIST

Before entering any enclosed space all the appropriate safety checks listed below must be carried out by the master or responsible officer and by the person who is to enter the space.

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 Are 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 ☑.

STRATEGY FOR DECK MAINTENANCE ON GEARED MINI-BULKER EMPLOYED IN EUROPEAN MIDDLE TRADES

Deck maintenance on these vessels is greatly affected by trading pattern and weather. It is impossible to carry out any extensive maintenance when engaged in a hectic shuttle service over short distances, or when deep laden in rough weather, even in the height of Summer. Even when this is acknowledged, however, it is possible to suggest guidelines, and to indicate where the emphasis can best be placed.

Spring time: March-May
Weather expected: mainly cold, or cool and damp.
Strip down and grease all moving gear throughout the ship following the reduced opportunities for maintenance during the winter: cargo blocks, derrick goosenecks, fairleads, deadmen, lifeboat davit sheaves, accommodation ladder gear, etc. Clean FW tanks. Hold painting if ship's employment permits.

Summer time: June-August
Weather expected: some mild or warm dry weather, suitable for painting.
First priority to be given to the painting of the topsides, deckhouses, decks, etc. Routine greasing. Hold painting if ship's employment permits.

Autumn: September-November
Weather expected: mainly cold, or cool and damp.
Strip down and grease all moving gear throughout the ship in preparation for the winter. Clean FW tanks. Overhaul/renew lifeboat wires and ropes every second year. Prepare for safety equipment survey/inspection. Hold painting if ship's employment permits.

Winter: December-February
Weather expected: bitter weather, with littles work possible outdoors.
Routine greasing throughout ship. Overhaul and maintain: power tools, spare cargo gear, spare anchoring and mooring gear, manual pumps in forecastle, galley and steering flat.
Check and clean safety equipment.
Overhaul and check small gear within enclosed lifeboats, and repaint lifeboat FW tanks and small gear lockers.
Renew pilot ladders and lifeboat ladders.
Recoat ballast tanks.
Unship and take under cover for maintenance: portable hold ventilators, accommodation ladder platforms.
Hatches, ventilators, lifelines, watertight doors, etc., ready for annual freeboard survey.
Clean out and tidy storerooms.
Grease ports, windows and deadlights within accommodation.
Painting within accommodation.

PLANNING OF A TASK

What result do I want to achieve?

The gritblasting and repainting of the main deck abreast No. 3 hold, port and starboard sides.

What is the sequence of steps required to achieve this result?

Step 1. Move gritblasting machine from the forecastle head to No. 3 hold starboard side.

Step 2. Move sacks of grit from forecastle head to No. 3 hold starboard side as required.

Step 3. Use gritblasting machine to gritblast deck plating.

Step 4. Gather up grit for re-use.

Step 5. Sweep deck. Wash down with high pressure fresh water.

Step 6. Apply metalbrite to deck plating with Kewgun or similar light weight high pressure hose/spray.

Step 7. Apply primer to deck plating with rollers.

Step 8. Apply deck paint to plating with rollers.

Step 9. Move gritblaster across deck to port side.

Step 10/15. Repeat Steps 3-8 on port side.

Step 16. Clean equipment and tools and prepare for storage.

Step 17. Return gritblasting machine to forecastle head.

Taking each step in turn, the following questions should be asked:

Step 1.

What are the necessary conditions?
- Gritblasting machine ready to use.

What tools and equipment are needed?
- Ramp or chainblocks for lifting machine over sill to forecastle store.

Do we have them aboard?
- Yes.

Are they all in good order?
- To be checked.

What difficulties may we meet?
- If ship is rolling the machine could "take charge" and break adrift, causing damage and injuries.

What safety precautions are required?
- Move the machine only when the ship is steady.
- Make sure that an officer, or an experienced petty officer, is in charge of shifting the machine.
- Secure the machine when it is in position on deck.

Action arising from the above review:
- Gritblasting machine to be checked to ensure it is in good working order.
- Ramp or chainblocks to be checked to ensure that they are in good working order and can be used to move the machine.
- Officer or experienced petty officer to be instructed to supervise the shifting of the machine, and to make sure that it is secured against movement when in position.

The Nautical Institute

202 LAMBETH ROAD
LONDON SE1 7LQ
Telephone: 01-928 1351

CONDITION REPORT of mv dated

Note : CHECK Column as satisfactory or otherwise using a reference for items requiring attention
DATE Column for date of supply, last testing etc

	CHECK	DATE		CHECK	DATE
1. PRESENT VOYAGE			4. GENERAL ITEMS		
Charts			Freeboard Tape		
Notices to Mariners			Hydrometer		
Sailing Directions			Lodicator		
Light Lists			- Instructs		
Routing Charts			- Paper		
Tide Tables			Timber Codes		
Current Atlas			IMO Codes		
AMVER Instructions			COW Manual		
Other Routing Info			SOLAS Book		
IMO TSS Handbook			Safe Working Practices		
Charter Party			Safety Plans - Ship		
Voyage Instructions			- Shore		
Cable Instructions			Fire Alarms		
Agents Addresses			Fire Detectors		
Cargo Papers			Gas Detectors		
Present Port Papers			Muster Lists		
2. CREW DOCUMENTS			Medical Stores		
Conditions of Service			Deck Log Books		
Individual Contracts			Voyage Abstracts		
Wages Information			Charterers Forms		
Passports			Port Papers		
Discharge Books			5. BRIDGE & NAVIGATIONAL		
Identity Cards			Navigation Lights - Main		
Medical Certificates			- Aux		
Officers Certificates			Aldis Lamp		
3. MASTERS DOCUMENTS			Whistle		
Document Check List			Bell & Gong		
Stability/Loading Manuals			Balls & Shapes		
Grain Loading Manual			Code Flags		
Anchor & Cable Certs			International Code Signals		
Medical Guide			Magnetic Compass		
Dangerous Drugs			Deviation Card		
Minor Certificates			Azimuth Book		
Safe Keys/Combination			Chronometer		
Official Log Book			Chronometer Rate Book		
Owners Instructions			Movement Book		
Owners Radio Codes			Chart Table Gear		

The Nautical Institute

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LONDON SE1 7LQ
Telephone: 01-928 1351

MASTER'S DOCUMENT CHECK LIST mv dated

Certificate of Registry	issued		
Flag State Tonnage Tax receipts	expire		
Flag State Certificate of Tonnage Measurement			
Flag State Annual Inspection Report	issued		
Minimum Safe Manning Certificate	issued		
Ship Radio Station Licence	expires		
Safety Radio Certificate	expires		
Safety Construction Certificate	expires		
Loadline Certificate	expires		
Safety Construction & Loadline last Annual Inspection			
Loadline Conditions of Assignment			
Safety Equipment Certificate (& Annex)	expires		
Safety Equipment last Intermediate/Annual Inspection			
Record of Inspection of Safety Equipment			
International Oil Pollution Prevention Certificate	expires		
Supplement (Record of Construction & Equipment)	issued		
Certificates of Class (Hull & Machinery)	issued		
Survey Certificates & Quarterly Listings	latest		
Liferaft Service Certificates	expire		
De Rat Exemption Certificate	expires		
Japanese Sanitary Inspection Certificate	expires		
Port State Control Inspection Report	latest		
United States Coast Guard Inspection Reports			
Valid Light Dues/Tonnage Tax Receipts			
USA Cert of Financial Responsibility (Water Pollution)	expires		
Civil Liability/Financial Responsibility Cert	expires		
TOVALOP Certificate	expires		
Employers Certificate of Insurance	expires		
Suez Canal Tonnage Certificate			
Panama Canal Tonnage Certificate			
Panama Canal Transit Identity Card			
Other Tonnage Certificates			
Annual/Intermediate Survey of Tankers	issued		
COW & IGS Operation Report	issued		
Cargo Gear/Chain Register - Last Annual Inspection			
- Last Quadrennial			
Oil Record Book - Engine Room			
- Cargo			
ITF Blue Certificate	expires		
Articles/Crew Agreement	expires		

Appendix 24.1

5. BRIDGE & NAVIGATIONAL (Continued)		
Gyro Compass		
Repeaters		
Azimuth Mirrors		
Auto Pilot		
Change over instructs		
Course Recorder		
- Paper		
Off Course Alarm		
Power Failure Alarm		
Direction Finder		
Calibration Table		
Radar No 1		
Radar No 2		
ARPA/Plotting		
Radar Log Books		
Echo Sounder		
- Paper		
Digital Display		
Loran		
Omega		
Decca Navigator		
Satellite Navigator		
Nav Aids Logs		
Sextant		
Tachometer		
Helm Indicator		
Speed Log		
Manouevring Data		
Steering Gear Alarms		
Changeover		
Barometer		
Thermometer		
Stevenson Screen		
Anemometer		
Hand Lead Line		
Window Wipers		
Line Throwing Gear		
Ships Pyrotechnics		
Navigation Tables		
Nav Publications		

5. BRIDGE & NAVIGATIONAL (Continued)		
Admiralty Chart Atlas		
Ships Chart Index		
Notices to Mariners		
Chart Correction Log		
Charts Corrected		
Light Lists Corrected		
Radio Signals Corrected		
Equipment Manuals		
Bridge Communications :		
to Engine Room		
to Steering Flat		
to Foscle		
to Poop		
to Radio Room		
to Master		
Watchkeepers Alarm		
6. LIFESAVING APPLIANCES		
Port Lifeboat :		
falls renewed		
fall ends reversed		
last swung		
last released		
last running		
Starboard Lifeboat :		
falls renewed		
fall ends reversed		
last swung		
last released		
last running		
Boat Engines		
Boat Gripes		
Boat Davits		
Releasing Gear		
Davit brakes		
Hoist Motor		
Hoisting cut outs		
Bowsing Tackles		
Lifelines		
Painters		
Embarkation Lights		

6. LIFESAVING APPLIANCES (Continued)		
Lifeboat Small Gear		
Lifeboat Provisions		
Lifeboat Water		
Lifeboat Fuel		
Lifeboat Pyrotechnics		
Boat Embarkation Ladders		
Skids & Grablines		
Main Liferafts		
Hydrostatic Releases		
Painter Ends Secured		
Forward Liferaft		
Lifebuoys		
Lifebuoys + Manoverboard		
+ Lights		
+ Ropes		
Lifejackets		
First Aid Kits		
Fire Extinguishers		
7. FIRE FIGHTING APPLIANCES		
Breathing Apparatus		
Spare Bottles		
Charging Compressor		
Firemans Outfits		
Protective Clothing		
Emergency Lamps		
Fire Main		
Hydrants on Deck		
Engine Room		
Accommodation		
Fire Hoses		
Jet Nozzles		
Jet/Spray Nozzles		
Fire Pump		
Emergency Fire Pump		
Galley Blanket		
Large ER Extinguishers		
Portable Extinguishers		
Extinguisher Refills		
Smothering System		
for Engine Room		
for Cargo Holds		

7. FIRE FIGHTING APPLIANCES (Continued)		
CO2 Bottles		
CO2 Release Alarm		
Foam Tank		
Foam Monitors		
Foam Last Sampled		
Automatic Shut Offs		
Manual Shut Offs		
Closing Appliances		
Internat Shore Connect		
8. DRILLS & TESTS		
Last Fire Drill		
Last Boat Drill		
Steering Tested		
Emergency Steering Tested		
9. RADIO EQUIPMENT		
Main Receiver/Transmitter		
Emergency Rec/Trans		
Emergency Batteries		
Auto Alarm		
Distress Watch Receiver		
Telex		
Satellite Terminal		
Facsimile		
Lifeboat Radio		
Main VHF Radio		
Remote VHF Sets		
Walkie Talkie Radios		
Spare Batteries		
Battery Charger		
Radio Aerials		
Publications		
Rad Off Cabin Alarm		
Radio Logs		
Emergency Instructions		

10. DECK EQUIPMENT		
Accommodation ladders		
Gangway Net		
Pilot Gear		
Pilot Hoist		
Windlass		
Windlass Brakes		
Anchors & Cables		
Securing Arrangements		
Forward Mooring Ropes		
Mooring Winches		
Fairleads & Rollers		
Canal Searchlight		
Smit Towing Bracket		
Aft Mooring Ropes		
Aft Mooring Winches		
Fairleads & Rollers		
Deck Lights		
Cargo Working Lights		
Pilot Ladder Light		

12. CARGO HOLDS/TANKS		
Condition No 1		
No 2		
No 3		
No 4		
No 5		
No 6		
No 7		
No 8		
No 9		
No 10		
Access Hatches		
Access Ladders		
DB Tank manholes		
Deep Tank Lids		
Bilge Suctions		
Hatch Coamings		
Hatch Rubbers		
Hatch Securing		
Hatch Lid Hose Test		
Hatch Opening/Closing		
Ventilators		
Fire Flaps on Vents		

12. CARGO HOLDS & TANKS (Continued)		
Tank Air Vents		
Ballast Tanks		
Ballast Pump		
Bilge Pump		
Submersible Pump		
Deck Pipelines		
Sounding Pipes		
Tank Gauging Devices		
Butterworth Openings		
Grain Trimming Openings		
COW		
IGS		
Pumproom Condition		
Main Cargo Pumps		
Stripping Pumps		
Eductors/Vac Strips		
Pumproom Bilges		
Pumproom Fans		
Duct Keel Access		
Oily Water Separators		
Oil Content Monitors		
Tanker Instruments		
Stripping Deck Line		
Oil Containment - Cargo - Bunkers		
Foscle Doors		
Masthouse Doors		
Superstructure Doors		
Ports & Scuttles		
02 Analiser		
USCG Oil Procedures Cargo		
Bunker		
Manifold Connections		
Manifold Saveall		
Bunker Connections		

13. MACHINERY SPACES		
Main Engines		
Main Boilers		
Auxiliary Boilers		
Steering Gear		
Generators		
Switchboards		
Emergency Generator		
Oily Water Separator		
Evaporator		
Bunker Tank Gauges		
Sea Inlets & Discharges		
Shaft Tunnel		
Stern Gland		
Propeller & Rudder		
Spare Propeller		
USCG Sanitation Devices		
UMS Alarms		
ER Access Alarms		
Cargo Winches		
Cranes		
Refrig Machinery		
Mechanical Vents - Holds		
- Accomm		
Air Conditioning		
Engine Room Skylight		
Walkways & Ladders		
Marking of Bilge Valves		
Marking of Ballast Valves		
Fuel Heating		
Fuel Oil Tanks		
Diesel Oil Tanks		
Lub Oil Tanks		
Bilge Tanks		
Miscellaneous Tanks		
Signed	Rank	Date
	Master	
	Ch Engr	
	Ch Mate	
	2nd Mate	
	Rad Off	

14. GENERAL CONDITION		
Forepeak Valve Operation		
Chain Lockers		
Accommodation Locks		
Cargo Gear		
Spare Wires		
Tallies on Blocks etc		
Provisions		
Storerooms		
Frig Chambers		
Galleys		
Galley exhaust trunks		
Laundry		
Hospital		
Bathrooms		
Fresh Water Tanks		
Public Rooms		
Crew Cabins		
External Shell Plating		
Main Decks		
Catwalks & Stairways		
Handrails & Bulwards		
Superstructure Decks		
Swimming Pool		
Deck Storerooms		
Changing Rooms		
Tally/Stevedore Offices		
Internal Alleyways		
Internal Fire Doors		
Heating Coils		
Container Fittings		
Container Lashings		
Timber Lashings		

BULK CARRIER LOSSES

Year	Vessel	Flag	Year Built /Age	Remarks
1977	*Eurobulker*	Cyprus	1963/14	Posted Missing
1978	*Vitasea Araba*	Greece	1958/20	Posted Missing
	Araba	Panama	1955/23	Posted Missing
	Munchen	W. Germany	1972/6	Presumed Sunk
1979	*Sea Pine*	Japan	1978/1	Posted Missing
	Kairali	India	1967/12	Posted Missing
	Myrina	Greece	1971/8	Posted Missing
	Berge Vanga	Liberia	1962/17	Presumed Sunk
1980	*Maria Bacolitsa*	Greece	1962/18	Found Sunk
	Mount Horizon	Panama	1970/10	Posted Missing
	Sam Kwang	S. Korea	1970/10	Posted Missing
	Hae Dang Wha	S. Korea	1968/12	Posted Missing
	Georgios G	Panama	1965/15	Posted Missing
	Derbyshire	UK	1976/4	Posted Missing
	Dunav	Yugoslavia	1973/7	Presumed Sunk
	Artemis	Liberia	1973/7	Presumed Sunk
	Poet	U.S.A.	1944/36	Posted Missing
	Sandalion	Italy	—	Abandoned/Sunk
1981	*Golden Pine*	Liberia	1968/13	Presumed Sunk
	Antiparos	Greece	1963/18	Presumed Sunk
	Delfovos	Greece.	—	Sunk
	Don Aurelio	Panama	1976/5	Posted Missing
	Onomichi Maru	Japan	—	Broke Up
	Mezada	Israel	—	Sunk
	Rugwardersand	W, Germany	1969/12	Posted Missing
	Rio Bravo	Greek	—	Sunk
	Leslie	Greece	1965/16	Posted Missing
	Marina di Equa	Italian	—	Abandoned/Sunk
	Wheststar	W. Germany	1966/15	Posted Missing
	Delta	Greece	1964/17	Posted Missing

ALL ABOVE DETAILS FROM LIVERPOOL UNDERWRITERS ASSOCIATION

ALL BELOW DETAILS FROM LLOYD'S REGISTER

Year	Vessel	Flag	Year Built /Age	Remarks
1982	*Academy Star*	Panama	—	Abandoned/Sunk
	Orient Treasury	Panama	—	Posted missing
1983	*Marine Electric*	USA	—	Capsized/Sunk
	Elena	Greek	—	Sunk
1984	*Themes K*	Greek	1961/23	Sunk
	Tito Campanella	Italian	1962/22	Posted missing
	Antacus	Liberia	1973/11	Abandoned/Sunk
	Char Ye	Panama	—	Abandoned/Sunk
	Hennigsdorf	DDR	1966/18	Abandoned/Sunk
	Kalliopi A	Greek	1969/15	Abandoned/Sunk
1985	*Hope Star*	S. Korean	1970/15	Abandoned/Sunk
	Tanfory	Panama	—	Abandoned/Sunk
	Winners Bee	Panama	—	Abandoned/Sunk
	Pab	Panama	—	Abandoned/Sunk
	Arctic Career	Panama	1966/19	Posted Missing
	Karin Vatis	Greek	1973/12	Abandoned/Sunk
1986	*Luchana*	Spain	1964/22	Broke up/Skunk
	Riviera Sky	Panama	—	Abandoned/Sunk
	Alexandros F	Panama	1978/8	Exploded/Abandoned
	De Bao	China	—	Sunk
	Brave Themis	Cyprus	1973/13	Abandoned/Sunk
1987	*Testarossa*	Philippines	1970/17	Sunk
	Cathay Seatrade	Liberia	1973/14	Sunk
	Tina	Cyprus	1974/13	Abandoned/Sunk
	Skipper I	Panama	1973/14	Abandoned/Sunk
	Cumberlande	Hung Kong	1973/14	Abandoned/Sunk
	Dayspring	Panama	1970/17	Abandoned/Sunk
	Star Carrier	S. Korea	1967/20	Abandoned/Sunk
	Alborada	Chile	1969/18	Sunk
	Queen Jane	Panama	1968/19	Presumed Sunk
1988	*Korean Star*	Panama	1984/4	Stranded/Broke
	Singa Sea	Philippines	1976/12	Sunk
	Mega Taurus	Panama	1980/8	Presumed Sunk
1989	*Kronos*	Bahamas	1973/16	Presumed Sunk
1989	*Star Alexandria*	Gibraltar	1965/24	Sunk
	Sevasti	Bahamas	1971/18	Sunk
	Huron	Cyprus	1972/18	Sunk
	Lung Hao	Panama	1966/23	Stranded/Broke
	Pan Dynasty	S. Korea	1968/21	Sunk
	Porn Udom	Thailand	1969/20	Presumed Sunk
	Norsul Trombetas	Brazil	1984/5	Stranded/Broke
	Vulca		1968/21	Sunk
1990	*Orient Pioneer*	Liberia	1971/19	Sunk
	Charlie	Greek	1975/15	Sunk
	Walter Leonhardt	W. German	1966/24	Sunk
	Alexandre P	Panama	1967/23	Sunk
	Azalea	Greek	1969/21	Sunk
	Tao Yuan Hai	China	1977/13	Sunk
	Silimna	Liberia	1978/12	Sunk
	Petingo	Vanuatu	1967/23	Sunk
	Corazon	Malta	1972/18	Sunk
	Pasithea	Liberia	1971/19	Sunk
	Algarrobo	Monaco	1973/17	Sunk
	Elounda Day	Panama	1973/17	Sunk
1991	*Protektor*	German	1967/24	Sunk
	Continental Lotus	India	1967/24	Sunk
	Salvia	S, Korea	1979/21	Sunk
	Vasso	Bahamas	1967/24	Sunk
	Starfish	Argentine	1970/21	Sunk
	Mineral Diamond	Hong Kong	1982/9	Presumed Sunk

Year	Vessel	Flag	Year Built /Age	Remarks
1991				
June	*Brant Team*	Norwegian	1976	Foundered. All 17 crew rescued
July	*Manila Transporter*	Philippine	1976	Abandoned. 24 rescued
July	*Choba*	Malta	1969	Sunk. 8 lost, 12 saved
July	*Ruth Riis*	Denmark	1988	Sunk in storm, 5 crew rescued
August	*Sunset*	Cyprus	1970	Sunk, flooded. Crew saved
August	*Blooming Orchard*	Taiwan	1970	Cracked, flooded and salved
August	*Petchomphoo*	Thailand	1969	Flooded forward. Found safe
August	*King William Ex-Pacifico-It)*	British	1974	Flooded, salved 27 crew
August	*Melete*	Greece	1975	Sunk rapidly, 25 missing, 2 rescued
August	*Anemi (Drycargo)*	Malta	1969	Flooded, salved
August	*Atlas Pride (0/0)*	Liberia	1973	Cracked, flooded, salved
October	*Erato*	Malta	1968	Sunk. 19 rescued, 6 lost
November	*Sonata*	Panama	1969	Cracked flooded under tow and sunk
November	*Hanjin Karachi*	S. Korean	1973	E.R. flooded; abandoned; 22 saved
November	*Entrust Faith*	Greek	1973	Flooded salved abandoned sunk
December	*Scaieni*	Romanian		Sank in Med storm, 10 missing from 26
1992				
January	*Captain Veniamis*	Greek	1967	Flooded, beached, refloated ctl Dec 92
January	*I. Van*	St. Vincent	1966	Hull leak repaired
January	*Arisan*	Panama	1974	Cracked and sunk
March	*Karadeni Z. S.*	Turkey	1969	Flooded and sank
May	*Golden Promise*	Cyprus		Heavy list (bad ballasting)
May	*Great Eagle*	Panama	1968	Cracked, flooded, sank, all 19 saved
August	*Trave Ore*	Panama	1968	Structural failure
October	*Dayang Honey*	Korea	1970	Believed sunk during typhoon
December	*Lika*	GRC	1976	Sprang leaks to cargo holds and hull; repaired
1993				
March	*Gold Bond Conveyor*	Liberian	1974	Sank. 32 missing from 33
May	*Nagos*	Panama	1969	Sank. 17 missing from 33
July	*River Plate*	Panama		Hole appeared in hull all rescued

BIBLIOLOGY

1. Lockhart, R. G. 'Hatch Cover Design and Related Experience.' *Joint Conference on Hatch Covers-Design, Installation, Operation and Maintenance.* Marine Media Management Ltd, January 1977.

2. Turnbull, D. E. 'Maintenance, Overhaul and Repairs to Hatch Covers.' *Joint Conference on Hatch Covers-Design, Installation, Operation and Maintenance.* Marine Media Management Ltd, January 1977.

3. Goldie, C. W. H. 'The Views of the P&I Club Manager. *Joint Conference on Hatch Covers-Design, Installation, Operation and Maintenance.* Marine Media Management Ltd, January 1977.

4. Bisset, A. and Hill, B. 'Some Typical Hatch Cover Defects in a Mixed Fleet.' *Joint Conference on Hatch Covers-Design, Installation, Operation and Maintenance.* Marine Media Management Ltd, January 1977.

5. Pitt, Captain C. T, OBE. 'Some Practical Experience with Steel Hatch Covers.' *Joint Conference on Hatch Covers-Design, Installation, Operation and Maintenance.* Marine Media Management Ltd, January 1977.

6. van Havre, J. 'Comments from a Cargo Surveyor and Adjuster.' *Joint Conference on Hatch Covers-Design, Installation, Operation and Maintenance.* Marine Media Management Ltd, January 1977.

7. Wolfram, J., BSc, PhD, C.Eng, MRINA. 'Factors Affecting Draft Surveys.' *Work of the Nautical Surveyor.* The Nautical Institute, 1989.

8. Strange, J. L., PhD, MNI. 'Improving the Accuracy of Draft Surveys.' *Work of the Nautical Surveyor.* The Nautical Institute, 1989.

9. Turner, J. E., C.Eng, BSc, MSc. 'Hog/Sag and Trim Corrections for Draft Surveys.' *Work of the Nautical Surveyor.* The Nautical Institute, 1989.

10. Stokoe, E. 'Weight/Volume Relationships Required Draft Survey Calculations.' *Work of the Nautical Surveyor.* The Nautical Institute, 1989.

11. Parker, Captain K, MNI. 'Measurement of Bulk Cargoes.' *The Mariner and the Maritime Law.* The Nautical Institute North East Branch, November 1990.

12. Stokoe, E. 'Apparent Density, Density and SG of Sea Water: What is the Difference?' Letter to *Seaways* October 1990.

13. Durham, C. F., FRMet S, AMIAM, MNI. *Marine Surveys.* Fairplay Publications, 1982.

14. The Measurement of Bulk Cargoes.' *Carefully to Carry,* UK P&I Club, No. 13, April 1989.

15. Wallace, R. I., BA, FInstPet, MCMS, MNI. Tank Calibration.' *Work of the Nautical Surveyor.* The Nautical Institute. 1989.

16. 'Care and Survey of Hatch Covers of Dry Cargo Ships.' The International Association of Classification Societies. *Work of the Nautical Surveyor.* The Nautical Institute. 1989.

17. Tinsley, D. *Short-Sea Bulk Trades.* Fairplay Publications Ltd. 1984.

18. *Code of Safe Practice for Ships Carrying Timber Deck Cargoes.* International Maritime Organization. 1991.

19. *ABB Master Crane Weighing* and other product literature. Asea Brown Boveri.

20. *The Bulk Carrier Register 1990.* Clarkson Research Studies Ltd, London. 1990.

21. Bell, N. The Freight Market-A Broker's View.' *Bulktrans* '91. CS Publications Ltd. 1991.

22. *Code of Safe Practice for Solid Bulk Cargoes.* International Maritime Organization. 1991.

23. Gilfillan, A. 'Developments in Bulk Carrier Design.' *Bulktrans* '89. CS Publications Ltd. 1989.

24. Buxton, Dr I. L., and Sen, Dr P. The Economics of Operation of VLBCs.' *Bulktrans* '89. CS Publications Ltd. 1989.

25. Wright, C., Wittington, M. and Currethers C. 'Delivered Cost Benefits with Self Unloading Vessels.' *Bulktrans '89.* CS Publications Ltd. 1989.

26. Haram, H. K. 'Large Bulk Carriers-Pushing Scale Economies Further.' *Bulktrans '91.* CS Publications Ltd. 1991.

27. Buxton, I. L., Daggitt, R. P. and King, J. *Cargo Access Equipment for Merchant Ships.* E. & F. N. Spon Ltd. 1978.

28. Buxton, I. L. and Logan, J. A. *The Ballast Performance of Ships with Particular Reference to Bulk Carriers.* RINA. 1986.

29. Muckle, W. *Naval Architecture.* Butterworths. 1987.

39. Parnell, G. Q., Master Mariner, FNI. *Ice Seamanship.* The Nautical Institute. 1986.

31. *The Mariner's Handbook,* Sixth Edition. NP100. The Hydrographer of the Navy. 1989.

32. *Ice Navigation in Canadian Waters.* TP5064. Canadian Coast Guard.

33. Caro, J. P., and Spink, H. E. 'Hong Kong Administration's View of Bulk Carrier Casualties & Losses.' *Intercargo/IBJSeminar.* Hong Kong. 1991.

34. IMO *Bulk Cargo Committee Document BC 30/17/Add.l.* Annex 3, p. 54.

35. Logan, J. A., and Chreseson, P. J. *The Application of Controllable Ballasting to Cargo Carrying Ships.* NECIES. 1986.

36. Croall, J. The Testing of HatchCovers Utrasonically: A Time Saving Technique.' *P&I International,* Vol. 5 No. 2 February 1991.

37. Lynch, R. J. *Steel Industry Bulk Cargoes-a guide for BHP personnel.* BHP Transport Ltd. 1980.

38. Fawbert, J. 'Bulk Port Design-An Expert Overview.' *Bulktrans* '91. CS Publications Ltd. 1991.

39. *MacGregor-Navire Technical Data Sheets* Nos. 8 (4/85), 10 (11/85), 11 (11/85), 12 (11/85), 13 (7/85), 14 (3/89).

40. UK Department of Transport *Merchant Shipping Notice No. M. 1122.* February 1984.

41. *Guidelines and Recommendations for the Safe Mooring of Large Ships at Piers and Sea Islands.* Oil Companies International Marine Forum. 1978.

42. *Port Handbook,* Dampier Port Authority, c1990.

43. *Advice to Vessels Bound for Port Cartier.* La Compagnie Miniere Quebec Cartier. 1989.

44. *Stability Information Booklet.* UK Department of Trade & Industry. 1973.

45. *The IMCO Grain Rules-Guidance Booklet.* UK Department of Trade. October 1976.

46. *IMO Grain Rules.* International Maritime Organization. 1982.

47. Peter, Hans J. 'The Prospects of Seaborne Bulk Trades-A Reassessment.' *Bulktrans '91.* CS Publications Ltd. 1991.

48. Derrett, D. R. *Ship Stability for Masters and Mates.* Stanford Maritime Ltd. 1984.

49. Thomas, O. O., Agnew J. and Cole K. L. *Thomas' Stowage-The Properties and Stowage of Cargoes.* Brown, Son & Ferguson Ltd. 1985.

50. *Building and Civil Engineering Terms.* BS 6100: Section 4.2: 1984. British Standards Institution.

51. Rigby, Dr G., and Hallegraeff, Dr G. *Ballast Water Exchange Trials and Marine Plankton Distribution on the mv* Iron Whyalla. BHP Research., 1992.

52. Phillips, C. 'Ship Stresses when Carrying Coal.' *Seaways.* October 1991.

53. Rogers, P., Strange, J. and Studd, B. *Coal Carriage by Sea.* Lloyd's of London Press. 1991.,

54. Moor, M. 'Coal-the Major Growth Sector of the Nineties.' *Bulktrans '91.* CS Publications 1991.

55. IMO Revised Schedules for Coal in the Code of Safe Practice for Solid Bulk Cargoes. *Swedish Club News.* May 1992.

56. Carriage of Coal. *UK P&I Club Circular 11/91.* September 1991.

57. Berry, Dr W. F. and Goscinski, J. S. 'Heating of Coals in Transit-Problems, Causes & Solutions.' *Seaways.* January 1983.

58. *Code of Practice for the Safe Handling and Ocean Transport of South African Coal.* South African Department of Transport.

59. Lower-Hill, B. J. *Lloyd's Survey Handbook.* Lloyd's of London Press Ltd. 1991.

60. *Code of Uniform Standards and Procedures for the Performance of Draught Surveys of Coal Cargoes.* United Nations Economic and Social Council. Economic Commission for Europe Committee on Energy, Working Party on Coal. 1992.

61. Ellison, D. 'Iron Ore-Still the Market Heavyweight.' *Bulktrans '91.* CS Publications. 1991.

62. 'Bulker Trimming Purge.' *Lloyd's List.* 20 August 1992.

63. Sparks, A. *Steel Carriage by Sea.* Lloyd's of London Press Ltd. 1988.

64. Llewellyn, T. J. *The Master's Role in Signing Bills of Lading.* Nautical Institute North East Branch. 1990.

65. *The Handling of Iron and Steel Products.* ICHCA Briefing Pamphlet No. 4. 1982.

66. Robertsson, S. and Lindemann, K. 'An Introduction to Ship Handling in Rough Weather.' *Veritas Report No. 81-0215.* DnV. 1981.

67. *Recommendations on the Safe Use of Pesticides in Ships.* IMO-267E. 1980, with Supplement dated 1984.

68. Macleod, Captain M., MNI. 'Spare Part Control and Planned Maintenance Using Computers.' *The Nautical Institute on Command.* 1986.

69. Phipps, D. *"Grab Operators' Handbook."* Arlona Engineering (Pty) Ltd, New Germany, South Africa.

70. Isbester, Captain J., ExC, FNI. 'Ship and Equipment Surveys-The Master's Responsibilities.' *The Nautical Institute on Command.* 1986.

71. Foster, H. 'Marine Paint Systems and their Application.' *The Nautical Institute on Command.* 1986.

72. Beattie, D. H. and Robson, A., C.Eng. 'A Review of Cargo Handling Systems for Dry Cargo Vessels.' *Transactions of the North East Coast Institution of Engineers and Shipbuilders,* Vo. 95. 1979.

73. *Code for Lifting Appliances in a Marine Environment.* Lloyd's Register of Shipping. 1981 with corrections to 1984.

74. Deck Crane Manuals from Liebherr, Germany, and Hagglunds, Sweden.

75. Hutchinson, J. L., C.Eng, MIMarE. 'Planning a Dry Dock.' *The Nautical Institute on Command.* 1986.

76. Campbell, A. 'Research Project Monitors Coal Cargo Heating at Sea.' *International Bulk Journal.* June 1992.

77. *Analysis of Major Claims.* The UK P&I Club. 1992.

78. Larking R. S., Captain. The Role of a Classification Society.' *International Command Seminar.* May 1992.

79. *Code of Safe Working Practices for Merchant Seamen.* Department of Transport. HMSO. 1991.

80. *Respiratory Protective Equipment: a Practical Guide for Users.* UK Health & Safety Executive. HMSO. 1990.

81. *Boarding and Access Regulations Gangways and Ladders.* Proceedings of a Nautical Institute London Branch Seminar. 1990.

82. *International Maritime Dangerous Goods Code.* International Maritime Organization. Consolidated Edition, 1990.

83. *Notes for the Guidance of Masters: Signing Bills of Lading for Bulk Cargoes.* Bibby Line, Liverpool. 1978.

84. Rayfield, R. *Nature & Function of the Bill of Lading and Mate's Receipts.* Nautical Institute North East Branch. 1990.

85. *Ship/Shore Safety Check List.* International Chamber of Shipping. 1992.

86. Aberkrom, P. 'Grabs-a Great Leap Forward.' *Bulktrans* '91. CS Publications. 1991.

87. Curline, J. R. (Editor). *Safe Loading, Ocean Transport and Discharge Practices for Dry Bulk Commodities.* The Australian Coal Association *et al.* 1992.

88. Moens, W. D. 'Optimal Routeing of Ships.' *Symposium on Weather Routeing of Ships,* London. 1970.

89. Mackie, Captain G. V. 'Weather Routeing of Ships.' *The Marine Observer.* 1981.

90. *Ocean Passages of the World,* 4th Edition. NP 136. Hydrographer of the Navy. 1987.

91. *Metroute: Worldwide Ship Routeing Services.* The Meteorological Office, Bracknell. 1991.

92. Foy, D. B., MRIN, FNI. 'Disasters at Sea and their Prevention.' *RSA Journal.* December 1987.

93. *Marpol 73/78.* International Maritime Organization. Consolidated Edition, 1991.

94. Meijers, J. H. C. 'Some Economical Aspects of the Routeing of Ships.' *Trans. IMarE,* 1980.

95. Akita, Y. 'A Challenge to Structural Failure in Ships.' *University of Glasgow Marine and Offshore Safety Seminar.* 1983.

96. *Code of Safe Practice for Cargo Stowage and Securing.* International Maritime Organization. 1992.

97. Richardson, Captain J., MNI. 'Total Loss: Some Possible Causes.' *Seaways,* April 1986.

98. Foy, D. B., MRIN, FNI. 'Bulk Carrier Losses-Unanswered Questions.' *Safe Ship-Safe Cargo Conference.* 1987.

99. AdamJ. C. 'Bulk Carriers-Defect Monitoring.' *Lloyd's Register Seminar.* May 1991.

100. Ferguson J. M. 'Bulk Carriers-The Challenge.' *Lloyd's Register Seminar.* May 1991.

101. Robinson D. W. The Bulk Carrier Research Project.' *Lloyd's Register Seminar.* May 1991.

102. Moeyaert, P. 'Circumstances in which Bulk Carriers are Operated.' *Lloyd's Register Seminar.* May 1991.

103. *Foundering of the* Melete. Report No. 34 of Australian Department of Transport & Communications. Undated.

104. *Bulk Carrier Casualties: Rule 5K-Classification and Statutory Requirements.* UKP&I Club. September 1991.

105. Beaumont, J. G. *Bulk carriers: guidance to operators on the inspection of cargo holds.* Lloyd's Register. October 1991.

106. *Casualty Report on the Loss by Grounding of* Petingo. Republic of Vanuatu. Undated.

107. *Bulk Carrier Losses.* Det norske Veritas. November 1991.

108. Bjorkman, A. *A Stronger & Better Bulk Carrier.* Pamphlet. September 1991.

109. 'Tougher New LR Rules for Bulk Carriers.' *Lloyd's Register Press Release.* November 1991.

110. Isbester, Captain J., ExC, FNI. 'Bulker Casualties-their Causes & Prevention.' *Bulktrans '91.* CS Publications Ltd. May 1991.

111. Reid, D. *et al.* 'Carriage of Steel in Bulk Carriers-Problems of Tanktop Loadings.' *The Work of the Nautical Surveyor.* Nautical Institute. 1989.

112. 'Bulk Carriers-Ships Safe to Sail in?' *Southampton Master Mariners' Club Technical Committee Seminar.* October 1991.

113. 'Bulkers-Side Shell Integrity Questioned.' *Marine Engineers Review.* July 1991.

114. Brooking, M. A. 'Loss of Bulk Carriers-A Naval Architect's Perspective.' *Seaways.* August 1991.

115. Maitland, G. E. C. The Flag State Outlook.' *Seaways.* August 1991.

116. 'Bulk/Combination Carriers Losses-the ABS Position.' *Seaways.* August 1991.

117. Beetham, Captain E. H., FNI. 'Loss of Bulk Carriers.' *Seaways.* May 1991.

118. Robinson, D. W. 'Bulk Carrier Casualties-A Classification Society's View.' *Intercargo Seminar,* Oslo. June 1991.

119. Polemis, S. M. 'Bulk Carrier Losses.' *Intercargo Seminar,* Oslo. June 1991.

120. 'What is the World Coming To?' Anon. *Journal of Master Mariners of Australia Inc.* Winter 1991.

121. Isbester, Captain J., ExC, FNI. 'Bulk Carrier Casualties and Losses-the Shipmaster's Point of View.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

122. Nunn, A. S. 'Bulk Carriers.' *Intercargo Seminar,* Oslo, June 1991.

123. Bau, Huyng due. 'Bulk Carriers Structural Damage.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

124. Kitashima, H. 'Shipbuilder's View of Bulk Carrier Casualties and Losses.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

125. Volkers, N. The Discharging Stevedore's View of Bulker Casualties.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

126. Piercy, P. 'Hamersley Iron Shiploading in Dampier.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

127. Jones, D. K. and Roe N. P. 'Bulk Carrier Casualties-an independent consultant's view.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

128. Wakasugi, T. 'Bulker Casualties-The Shipowner's View.' *Intercargo /IBJ Seminar.* Hong Kong. October 1991.

129. Wingfield, S. 'Bulker Casualties-the Views of Cargo Interests.' *Intercargo/IBJ Seminar.* Hong Kong. October 1991.

130. *Casualties to Bulk Carriers.* Liberian Shipowners' Council. January 1992.

131. 'HTS-Something for Nothing?' *100A1 magazine.* Issue 3, 1992.

132. Barnet, Captain S., MNI. 'What the World has Come to.' *Seaways,* July 1993.

133. 0rbeck F. 'Wave-excited hull vibration reduction using hull vibration damper.' *Institute of Marine Engineers.* March 1992.

134. Corlett, B. J., and Colman, J. C. 'Bulk Carrier Losses-A Naval Architect's Viewpoint.' *MLAANZ Conference.* 1992.

135. Isbester, Captain J., ExC, FNI. The Operation of Bulk Carriers-the Seagoing Perspective.' *Royal Institution of Naval Architects.* December 1992.

136. Avrin, K, and Spence, N. The Harland & Wolff New Bulk Carrier Design for Improved Safety and Longevity.' *Royal Institution of Naval Architects.* December 1992.

137. 'Special Action to Improve Safety of Older Bulk Carriers.' *Germanischer Lloyd Magazin.* December 1992.

138. Kruszewski, Dr A. 'Sliding Solid Bulk Cargoes: How to Avoid Them.' *ICHCA Annual Review,* 1992.

139. Isbester, Captain J., ExC, FNI. 'Bulk Carrier Operations.' *Ports and Shipping Seminar.* Karachi, January 1993..

140. Jubb J. E. M. 'Bulk Carriers-Fatally Flawed?' *Welding and Metal Fabrication.* May 1992.

141. 'Losses of Bulk Carriers during 1990.' *Lloyd's Register Press Release.* January 1991.

142. Foy, D. B., MRIN, FNI. 'Combination Carriers, Ore Carriers and Sudden Sinkings.' *Safety at Sea.* February 1983.

143. Aksu, S. *et al.* 'Load & Stress Distributions on Bulk Carriers and Tankers in Various Loading Conditions.' *Royal Institution of Naval Architects.* December 1992.

144. Isbester, Captain J., ExC, FNI. Tankers and Bulk Carriers: the Way Ahead.' *Seaways.* February 1993.

145. *Investigation Report on the Capsizing of the Pusher Vessel* Finn *and the Barge* Baltic *off Hanko.* Accident Report No.2/1990. Helsinki. 1992.

146. Keith, Captain B. R, MNI. 'Loading of Large Bulk Carriers.' *Seaways.* February 1993.

147. Isbester, Captain J., ExC, FNI. 'Bulk Carrier Practice.' *Seaways.* May 1992.

148. Baillod, Captain F., MNI. Private correspondence. 31 October 1992.

149. 'Framework-a system of ladders.' *Seaways.* January 1993.

150. *Bulk Carriers: Guidance and Information to Shipowners and Operators.* International Association of Classification Societies. April 1992.

151. Burton, J. A. *Enhanced Surveys for Tankers and Bulk Carriers.* Lloyd's Register. January 1993.

152. *Safety Aspects of Ship Design and Technology.* House of Lords' Select Committee on Science and Technology (The Carver Committee). HMSO. February 1992.

153. Baldwin, K. G. 'Hold Washing and Pollution.' *Seaways.* July 1992.

154. Boyle, Captain P., FNI. 'Bulk Carriers: Operational Aspects which Might Lead to Loss.' *Safe Ship Safe Cargo Conference,* September 1987.

155. Smith, Campbell, BSc, MSc, MCIT, MNI. 'Cargo Handling for Bulk Carrier Fleets.' *Symposium on the Operation of Large Ships.* RINA/NI. March 1976.

156. Lanham, Captain B. D., MNI. 'Bulk Carrier Losses.' *Seaways* September 1991.

157. Skinner, Dr A. E. *et al.* 'Notes on Bulk Carrier Cargo Liquefaction.' *RINA London branch seminar.* August 1991.

158. *Annex to IMO Resolution A. 713* (17). IMO. November 1991.

159. Isbester, Captain J., ExC, FNI. 'Structural Damage to Bulk Carriers from Block Loading.' *Seaways.* July 1993.

160. Price, Prof G. Second Wakeford Maritime Lecture. February 1991.

161. 'Solution-LR's Ship Event Analysis Notation.' *100A1,* Issue 1 1991.

162. 'Safey Demands Legislation.' *The Motor Ship.* May 1991.

163. The Structural Price of Port Pressures.' *Lloyd's List.* 17 September 1991.

164. Hachmann, D. 'Wave Load Rules Unreasonable.' *Lloyd's List.* 9 October 1991.

165. Bjorkman, A. I. C. H. 'Big Bulkers Should be Stronger.' *Lloyd's List.* October 1991.

166. Baillod, Captain R, MNI. 'Shipping's Deep Crisis.' *Seaways.* October 1991.

167. Knight, Captain R., MNI. 'Focus on Bulk Carriers.' *Seaways.* October 1991.

168. Berkley, Captain C., MNI. 'More Research, Less Theorising Please.' *Lloyd's List,* December 1991.

169. Ramwell, Captain D. C., MNI. The Bulker Safety Debate Continues.' *MER.* January 1992.

170. Skinner Dr A. 'Cargo Liquefaction.' *MER.* October 1991.

171. Lloyd, Captain C. M. R., FNI. The Flaws in Class Advice on Bulkers.' *Lloyd's List.* 22 January 1992.

172. Noble, J. M., BSc, FNI. 'Bulk Carrier Losses.' *Seaways.* March 1992.

173. Bjorkman, A. I. C. H. 'Weak Bulk Carriers.' *Seaways.* March 1992.

174. Robinson D. W. 'P & O Voyage Recorder Move Put into Perspective by LR.' *Lloyd's List.* 2 April 1992.

175. Tye, Captain T. J. 'Figures Hide why Bulk Carrier Sinkings are still a Problem.' *Lloyd's List.* 14 August 1992.

176. Ferguson, J. M. 'Informed Opinion is Crucial for Bulk Carrier Safety.' *Lloyd's List.* 19 August 1992.

177. Timmins, I. G., AMNI, FIGS, ACIArb, MCIT. The Myth of the Self Trimming Bulk Carrier.' *Seaways.* July 1993.

178. *Recommendations for Bulk Carrier Safety.* International Association of Dry Cargo Shipowners. January 1992.

179. Foy, D. B., MRIN, FNI. 'Marine Enquiries & the Public Interest.' *Trans IMarE.* November 1982.

180. Robinson, D. W. 'Bulk Carrier Research-LR Project.' *Seaways.* October 1991.

181. Botterill, Captain G. J., FIGS, FNI. 'Quality Assurance in Ship Management.' *IME.* March 1993.

182. *Pilot Study into Loading of Bulk Carriers.* Report from Australia to IMO Maritime Safety Committee. MSC 60/20/5.

183. *Safety of Ships Carrying Solid Bulk Cargoes.* Document submitted by the Government of France to the IMO Maritime Safety Committee. MSC 60/20/8.

184. *Improved Design and Construction Standards for Bulk Carriers.* Document submitted by Hong Kong to IMO Sub-Committee on Design & Equipment. DE35/INF.

185. McDowell, D., AMNI. 'Bulk Carrier Corrosion-Recent Experiences.' *Seaways.* August 1991.

186. 'Incentives Needed to Upgrade Bulker Fleet.' *The Motor Ship.* November 1992.

187. Foy, D. B., MRIN, FNI. 'Safety and 1985.' *Safety at Sea.* December 1985.

188. *The Management of Safety in Shipping.* The Nautical Institute. 1991.

189. *The Master's Role in Collecting Evidence.* The Nautical Institute. 1989.

190. Foy, D. B., MRIN, FNI. 'Safety and 1987.' *Safety at Sea.* December 1987.

191. *Bills of Lading: Delivery of Cargo Against one Original Bill of Lading Carried on Board.* The London Steam-Ship Owners' Mutual Insurance Association Ltd. Circular. July 1990.

192. Robinson, D. W. 'The Safe Loading & Unloading of Bulk Carriers.' *R1NA, London Branch.* 1993.

193. Hinz, C. 'If Ship Safety Ruled the Waves.' *Bulktrans '93.* CS Publications Ltd.

194. McKay, Captain B. The Canadian Coast Guard Bulk Carrier Inspection Regime.' *Bulktrans '93.* CS Publications Ltd.

195. Bolitho, W. 'The Future Facing Substandard Shipping in the Australian Trade.' *Bulktrans '93.* CS Publications Ltd.

196. *Shipping and the Environment-a Code of Practice.* International Chamber of Shipping. 1993.

197. *Ponta da Madeira Terminal Port Information.* Companhia Vale do Rio Doce. 1988.

198. Instrument Operating Literature from MSA, Explosimeter, Neotex, Servomex, Drager.

199. Equipment Operating Literature from Atlas Copco, Clenico, Graco, Wilden Pumps, StrOmme, Flexotube-Trident, Nitto Kohki Co Ltd, Paul & Griffin, Fujiki Trading Co Ltd, Kobe Cleaner MFC Co, Yati.

200. 'Substandard Ships and the Shipmaster.' NI Substandard Ship Working Group. *Seaways.* February 1990.

201. Rans, Philip. 'UK coal imports and terminal investment.' *Bulktrans '93.* CS Publications Ltd.

202. Instruction leaflets supplied with hydrometers from G.H. Zeal Ltd, London, England.

INDEX

NAUTICAL INSTITUTE CARGO OPERATIONS CONTROL FORM

Programme version No:	No of Loaders / Dischargers	

Ship:	Load / Disch. Port:	Max Draft Available (HW):	Max Airdraft in Berth:	Assumed SF of Cargo:	Ballast Pumping Rate:
Date Commenced:	Max Sailing Draft:	Min Draft Available (LW):	Dock Water Density:	Last Cargo:	Load / Disch Rate:

	11	10	9	8	7	6	5	4	3	2	1
Tonnes Grade											

Totals: Grade: Tonnes Grade: Tonnes Grade: Tonnes Total: Tonnes

Pour No	Cargo		Ballast Operations	Time Req'd (Hrs)	Comments	Calculated Values				Calculated Values			Observed Values		
						Draft		Maximum					Draft		
	Hold No	Tonnes				F	A	BM*	SF*	Air Draft	Draft Mid	Trim	F	A	Mid
TOTAL:															

Signed on behalf of Stevedores ____________ Signed Chief Mate ____________

All entries within the box must be completed as far as possible. The entries outside the box are optional

NO DEVIATION FROM ABOVE PLAN WITHOUT PRIOR APPROVAL OF CHIEF MATE
*BM & SF to be expressed as % of maximum permitted values.
Pours to be numbered 1A, 1B, 2A, 2B, etc when using two loaders.
Abbreviations: PI = Pump In GI = Gravitate In F = Full
PO = Pump Out GO = Gravitate Out MT = Empty

BULK CARRIER PRACTICE

Captain J Isbester ExC FNI