An Introduction to the Technical, Operational and Commercial Aspects

Nigel Draffin
SHIPPING
An Introduction to the Technical, Operational and Commercial Aspects
Dedication

This book is dedicated to the people who make shipping work. The people on the ships, the people who work in harbours, docks and shipyards, the pilots, surveyors, maritime lawyers, maritime regulators and all of those who arrange the business of ships and shipping. Most of them never feature in the various awards ceremonies held each year but without them there would be no shipping industry.

Nigel Draffin
SHIPPING
An Introduction to the Technical, Operational and Commercial Aspects
by
Nigel Draffin
M.I.Mar.E.S.T.

First Edition

Foreword by
Peter Hinchliffe OBE
Secretary General
International Chamber of Shipping

Published by
Petrospot Limited
England
2014
Shipping is as international, diverse, challenging and complex as any industry could ever be. But it is also uniquely absorbing and rewarding.

The industry is changing very quickly. Ships are getting bigger, ports are getting deeper and the Panama Canal is getting wider. The Northern Sea Route is opening up and trading patterns are changing. As the centre of gravity of the industry continues to shift eastwards, oil and commodity markets have seldom been more volatile, freight rates under more pressure or finance harder to come by. Improvements in technology and communications are coming thick and fast. Sustainability has become the buzzword and requirements on air emissions and ballast water are forcing the pace of change. The fuels are changing too, with liquefied natural gas (LNG), methanol, glycerol and others now vying for attention as distillates mount a challenge on the dominance of heavy fuel oil. The interest in abatement technology is steadily growing.

Against this background, the need for industry knowledge, education and hands on experience has never been greater, both at sea or onshore. In this context, this book by shipping and bunker industry expert Nigel Draffin is a perfect starting place.

Shipping: An Introduction to the Technical, Operational and Commercial Aspects aims to educate and inform newcomers to shipping and those whose jobs require a basic grasp of how the industry works. In that respect it handsomely delivers. The book offers a valuable insight into all aspects of shipping and deserves its place alongside the specialist technical and academic books available elsewhere.

It outlines the types of ships plying the world’s oceans and the vast support infrastructure required to service the supply chain and keep the ships moving. It begins by looking at world trade and cargo flows and examines the fundamental properties of ships – why do they float; why do they sink? – before identifying the categories of vessel currently in service. It will be as helpful for the novice as it will be interesting for the more experienced seafarer or shipping professional.

Nigel’s book takes the reader through the duties expected of the crew, from watchkeeping to catering, and looks at manning, training, welfare and crew retention. It covers navigation and traffic management systems, communications and onboard safety. There are sections on classification and insurance, international conventions and national maritime law.

Nigel looks at ports and the services they offer, such as pilots and agents, cranes and dry docks. He also examines the many types of craft operating in ports.

Ships exist to make money for the owners and charterers, and the financial aspect of shipping is not ignored. Nigel looks at charter parties and contracts of
affreightment, at shipbroking and vessel vetting, and at the main costs, such as
manning, maintenance, insurance and bunkering. He covers sale and purchase,
new building and scrapping, as well as ownership structures, mortgages and
public and private ownership issues.

Ships would sail nowhere without propulsion systems and Nigel excels in
describing the engines and propellers, speed and efficiency, and puts into context
the issues of greenhouse gases, emissions regulation and pollution.

Piracy and the proliferation of high risk areas are now key issues for crews and
ships and are therefore covered. So too are disputes, ship arrest, liens, claim
resolution, mediation and arbitration.

Nigel provides a handy ‘where to go for help’ section and a glossary of abbreviations
and shipping terms. The book also includes some helpful appendices to illustrate
what might be found in voyage and time charter contracts.

All in all, this is a very accomplished piece of work which I am certain will be a
great asset to anyone embarking on a career in international shipping or wanting
to know more about different sectors of this great global industry.

I am very grateful to Nigel Draffin for having brought this book to fruition and am
delighted to recommend it.

Peter Hinchliffe OBE
Secretary General
International Chamber of Shipping

May 2014
Preface

In early 2013, Llewellyn Bankes-Hughes asked me if I would write a book on shipping – when I asked why, he said that there was a need for a book which explained the basics of ships and shipping for new entrants to the maritime sector and for non-specialists. At first I was unsure that I could contribute anything useful but, as I thought about his suggestion, I realised that most of the existing works on this subject were quite specialised and did not present the ‘whole picture’ of shipping at an accessible level. I hope that this book will enable people to put all the different parts of the business of ships, cargo and shipping commerce into context and to find the answers to most questions about the industry that are outside their experience.

This is not a high-level academic work nor is it a text book for professional study. It is a book that will hopefully increase understanding for new entrants to the industry and those moving from one sector to another. There will be many omissions and, I am sure, some errors, for which the fault is mine. However, I have been fortunate to have had the help and guidance of a great number of industry professionals and specialists in the production of the text.

If I manage to increase understanding of our industry then I will be content.

Nigel Draffin

May 2014
Shipping: An Introduction to the Technical, Operational and Commercial Aspects is a much-needed and unique addition to the plethora of specialist books already available on almost every aspect of the global shipping industry. The fact that it has been written by Nigel Draffin, a proven expert many times over in shipping and bunkering, guarantees that it will be comprehensive, accessible to everyone who needs to learn the basics about shipping and also very useful for anyone who, on occasion, may need to check forgotten facts or find a starting point for further research.

This book is Nigel’s seventh but the first to look into the diverse and complex world of shipping. His previous six titles all deal with bunkering in some form or other, including liquefied natural gas (LNG) bunkering, ships’ engines and commercial issues, but this book sails a new course.

Nigel has been involved in shipping for almost 50 years and with the commercial bunker market for over 25 years. After joining Shell Tankers as an apprentice engineer in 1966, he progressed through the ranks, serving on all classes of vessel, including very large crude carriers (VLCCs) and LNG tankers. He came ashore in 1979 to join the newbuilding department of Shell International Marine. After two years of new construction in Ireland, South Korea and the Netherlands, he transferred to Shell’s Research & Development unit, specialising in control systems, fuel combustion and safety systems.

In 1986, Nigel moved to the commercial department as a bunker buyer and economics analyst. In 1988, he was promoted to be Head of Operational Economics, responsible for all of the fuel purchased for the Shell fleet, the operation of the risk management policy and the speed/performance of the owned fleet. In March 1996, he joined the staff of E.A. Gibson Shipbrokers Ltd in the bunker department, and became the manager. In 2006, this department merged with US-based broking house LQM Petroleum Services, where Nigel is currently Senior Broker and Technical Manager.

Nigel is a founder member of the International Bunker Industry Association (IBIA) and has served several times on its council of management and executive board. He has also served as the association’s Chairman. He is the author of IBIA’s Basic Bunkering Course and Director of Petrospot’s leading training events, the Oxford Bunker Course, the Oxford Bunker Course (Advanced), and An Introduction to LNG Bunkering. Nigel is a member of the Institute of Marine Engineering, Science and Technology and Past Master of the Worshipful Company of Fuellers.

Llewellyn Bankes-Hughes
Managing Director, Petrospot Limited

May 2014
Acknowledgements

The author extends his thanks to everyone who has helped in the creation of *Shipping: An Introduction to the Technical, Operational and Commercial Aspects*, particularly Doug Barrow, Steve Christie, Trevor Harrison and David Hughes who suggested many additions and changes which hopefully make the book better. He also extends his thanks to Llewellyn Bankes-Hughes and his team at Petrospot for suggesting the idea in the first place and, in particular, to Lesley Bankes-Hughes and Cheryl Marshall who have seamlessly designed and produced the finished article.

**Nigel Draffin**

May 2014
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>v</td>
</tr>
<tr>
<td>Preface</td>
<td>vii</td>
</tr>
<tr>
<td>About the author</td>
<td>ix</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>xi</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Notes</td>
<td>3</td>
</tr>
<tr>
<td><strong>Chapter 1 - World trade</strong></td>
<td>5</td>
</tr>
<tr>
<td>Trade routes</td>
<td>6</td>
</tr>
<tr>
<td>Trade routes by vessel density</td>
<td>7</td>
</tr>
<tr>
<td>Shipping ‘choke points’</td>
<td>7</td>
</tr>
<tr>
<td>Cargo flow</td>
<td>8</td>
</tr>
<tr>
<td><strong>Chapter 2 - Ship fundamentals</strong></td>
<td>13</td>
</tr>
<tr>
<td>How ships float</td>
<td>13</td>
</tr>
<tr>
<td>Why ships stay upright</td>
<td>14</td>
</tr>
<tr>
<td>Why do ships sink?</td>
<td>15</td>
</tr>
<tr>
<td>Ship dimensions</td>
<td>16</td>
</tr>
<tr>
<td>Describing a ship</td>
<td>16</td>
</tr>
<tr>
<td>Will the car fit in the garage?</td>
<td>16</td>
</tr>
<tr>
<td>Diagram of vessel dimensions</td>
<td>17</td>
</tr>
<tr>
<td>Table of vessel dimensions</td>
<td>18</td>
</tr>
<tr>
<td>Tonnage</td>
<td>19</td>
</tr>
<tr>
<td><strong>Chapter 3 - Ship types</strong></td>
<td>21</td>
</tr>
<tr>
<td>Cargo ship arrangement</td>
<td>21</td>
</tr>
<tr>
<td>General cargo</td>
<td>25</td>
</tr>
<tr>
<td>Specialist dry cargo</td>
<td>26</td>
</tr>
<tr>
<td>Car carriers</td>
<td>26</td>
</tr>
<tr>
<td>Roll-on Roll-off (Ro-Ro)</td>
<td>27</td>
</tr>
<tr>
<td>Heavy lift</td>
<td>28</td>
</tr>
<tr>
<td>Dock ships</td>
<td>28</td>
</tr>
<tr>
<td>Tankers</td>
<td>29</td>
</tr>
<tr>
<td>Oil</td>
<td>30</td>
</tr>
<tr>
<td>Tanker size table</td>
<td>31</td>
</tr>
<tr>
<td>Gas</td>
<td>31</td>
</tr>
</tbody>
</table>
Chapter 4 - Onboard ship

Organisation .................................................................................................................. 49
  Watchkeeping ............................................................................................................. 49
  Deck department ........................................................................................................ 50
  Engine department ..................................................................................................... 50
  Catering department .................................................................................................. 51

Manning ....................................................................................................................... 51
  Training ....................................................................................................................... 51
  Retention ..................................................................................................................... 51
  Welfare ......................................................................................................................... 52

Navigation .................................................................................................................... 52
  Traffic separation systems ......................................................................................... 53
  Navigational marks and aids ....................................................................................... 53
  Buoyage systems ......................................................................................................... 53
  Lighthouses .................................................................................................................. 55
  Navigation lights ......................................................................................................... 55
  Collision Regulations (ColRegs) ................................................................................ 55
  Aids to memory in four verses ................................................................................... 55

Communication ............................................................................................................ 56

Safety onboard .............................................................................................................. 57
SHIPPING

Port vessels ........................................................................................................................................................................... 84

Barges .................................................................................................................................................................................. 84
Tugs ..................................................................................................................................................................................... 85
Workboats ............................................................................................................................................................................. 86
Dredger .................................................................................................................................................................................. 86
Floating dock ....................................................................................................................................................................... 87
Floating crane ...................................................................................................................................................................... 88

Locks................................................................................................................................................................................... 89

Chapter 9 - Canals ....................................................................................................................................................................................... 93

Suez Canal ........................................................................................................................................................................... 93
Panama Canal ........................................................................................................................................................................ 95
Kiel Canal ............................................................................................................................................................................ 96

Chapter 10 - Making money ......................................................................................................................................................................... 99

Chartering ............................................................................................................................................................................... 99

Voyage chartering .................................................................................................................................................................... 99
Bill of lading ........................................................................................................................................................................... 100
Hague Rules ........................................................................................................................................................................ 100
Hague-Visby Rules ............................................................................................................................................................. 100
Hamburg Rules ................................................................................................................................................................... 100
Rotterdam Rules .................................................................................................................................................................. 101
Worldscale .............................................................................................................................................................................. 101
International Commerce Terms (INCOTERMS) ....................................................................................................................... 102

Contract of Affreightment (COA) ................................................................................................................................................... 102

Time chartering ..................................................................................................................................................................... 102
Trip time chartering ............................................................................................................................................................. 103
Bareboat chartering .............................................................................................................................................................. 103

Shipbroking ........................................................................................................................................................................... 103

Ship vetting ........................................................................................................................................................................... 104
Tanker vetting ........................................................................................................................................................................ 104
Dry bulk vetting ..................................................................................................................................................................... 104

Chapter 11 - Major cost elements .................................................................................................................................................. 107

Maintenance ........................................................................................................................................................................... 109
Stores and spares ................................................................................................................................................................. 109
Insurance ................................................................................................................................................................................ 109

Bunkering ............................................................................................................................................................................ 110

Port charges ........................................................................................................................................................................ 110

Chapter 12 - Ship propulsion .............................................................................................................................................................. 113

Engines .................................................................................................................................................................................. 113
Propellers .............................................................................................................................................................................. 114
Manoeuvring .......................................................................................................................................................................... 115

Speed ................................................................................................................................................................................ 118
# Appendix 1 - Where to go for help

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine fuels – technical and legal information</td>
<td>175</td>
</tr>
<tr>
<td>General</td>
<td>175</td>
</tr>
<tr>
<td>Marine surveying</td>
<td>176</td>
</tr>
<tr>
<td>Shipping law</td>
<td>176</td>
</tr>
</tbody>
</table>

# Appendix 2 - Ship sizes and dimensions

**Page 177**

# Appendix 3 - Commercial agreements

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model voyage charter (extract)</td>
<td>181</td>
</tr>
<tr>
<td>Model time charter extract</td>
<td>183</td>
</tr>
<tr>
<td>Summary of INCOTERMS</td>
<td>187</td>
</tr>
<tr>
<td>Any mode of transport</td>
<td>187</td>
</tr>
<tr>
<td>Sea and inland waterway transport</td>
<td>188</td>
</tr>
</tbody>
</table>

# Index

**Page 191**
List of Figures

Figure 1. World seaborne trade 1980-2012 ................................................................. 5
Figure 2. Shipping routes .......................................................................................... 7
Figure 3. The choke points on shipping trade routes ................................................. 7
Figure 4. World crude oil exports by destination 2012 ............................................. 9
  Image courtesy of OPEC (www.opec.org)
Figure 5. Coal trade flow by origin and destination ................................................ 10
Figure 6. Container cargo flow ............................................................................... 11
Figure 7. Plimsoll line ............................................................................................. 13
Figure 8. Plimsoll line detail .................................................................................... 14
Figure 9. Stability diagram ...................................................................................... 15
Figure 10. Shipping diagram (front) ......................................................................... 17
Figure 11. Shipping diagram (side) ......................................................................... 17
Figure 12. Elevation of SS American Racer ............................................................ 21
Figure 13. Plan of SS American Racer .................................................................... 22
Figure 14. Traditional ‘break bulk’ general cargo ship of the 1970s ......................... 22
Figure 15. Traditional 1950s oil tanker ................................................................ 23
Figure 16. Double hull modern VLCC .................................................................... 24
Figure 17. Handy size bulk carrier of the last 10 years ............................................. 24
Figure 18. General cargo ship ................................................................................ 26
  Photograph courtesy of Nigel Draffin
Figure 19. Ro-Ro vessel ....................................................................................... 27
  Photograph courtesy of Nigel Draffin
Figure 20. Heavy lift ship ...................................................................................... 28
  Photograph courtesy of Nigel Draffin
Figure 21. Dock ship Blue Marlin with Ocean Monarch .......................................... 29
  Photograph courtesy of Dockwise (www.dockwise.com)
Figure 22. The Batillus tanker in Saint-Nazaire ...................................................... 30
  Photograph attributed to Jacques Girard
Figure 23. Coastal tanker ..................................................................................... 31
  Photograph courtesy of Nigel Draffin
Figure 24. The Arctic Princess LNG tanker ............................................................ 32
  Photograph courtesy of Höegh LNG (www.hoeghlng.com)
Figure 25. LPG pressurised tanker ....................................................................... 33
  Photograph courtesy of Nigel Draffin
Figure 26. Handy size bulker ............................................................................... 34
  Photograph courtesy of Nigel Draffin
Figure 27. Container small geared feeder ............................................................... 37
  Photograph courtesy of Nigel Draffin
Figure 28. Container ship ..................................................................................... 37
  Photograph courtesy of Nigel Draffin
Figure 29. *Atlantic Klipper* reefer vessel................................................................. 38
    Photograph courtesy of Seatrade (www.seatrade.com)
Figure 30. The *Salica Frigo* .................................................................................... 38
    Photograph courtesy of Clipper (CC BY 2.5)
Figure 31. The QE2 at South Queensferry .................................................................. 39
    Photograph courtesy of Tim Dyer
Figure 32. The *MS Majesty of the Seas* ................................................................... 40
    Photograph courtesy of Matt H. Wade (CC BY 3.0)
Figure 33. High speed ferry underway ...................................................................... 41
    Photograph courtesy of Nigel Draffin
Figure 34. Passenger ferry ....................................................................................... 41
    Photograph courtesy of Nigel Draffin
Figure 35. Modern anchor handling tug supply vessel (AHTS) .................................. 42
    Photograph courtesy of MAN Diesel & Turbo (www.mandieselturbo.com)
Figure 36. The *Maria S Merian* in Reykjavik ......................................................... 44
    Photograph courtesy of Estermiz (CCO 1.0)
Figure 37. Merchant ship escorted by a Finnish icebreaker ....................................... 45
    Photograph courtesy of Kalle Inkinen (CC BY-SA 3.0)
Figure 38. Finnish icebreaker *Otso* showing the icebreaking bow ......................... 45
    Photograph courtesy of Jukka Koskimies (CC BY-SA 3.0)
Figure 39. *IT Intrepid* ............................................................................................. 46
    Photograph courtesy of International Telecom (www.ittelecom.com)
Figure 40. The guided-missile destroyer *USS Jason Dunham* .................................. 47
    Photograph courtesy of the US Navy
Figure 41. New buoy .................................................................................. 54
    Photograph courtesy of Nigel Draffin
Figure 42. Old buoy .................................................................................. 54
    Photograph courtesy of Nigel Draffin
Figure 43. Free fall lifeboat ........................................................................ 57
    Photograph courtesy of Trevor Harrison
Figure 44. A combined winch and windlass on the forecastle of a tanker .................. 58
    Photograph courtesy of Rolls-Royce plc (www.rolls-royce.com)
Figure 45. Mooring ropes ........................................................................ 59
    Diagram courtesy of Petrospot
Figure 46. The elements of a combined winch-windlass ........................................... 60
    Photograph courtesy of Welkinridge
Figure 47. 20-tonne anchor in the anchor pocket on a warship .................................. 61
    Photograph courtesy of the US Navy
Figure 48. Memoranda of understanding ................................................................. 74
    Picture courtesy of Kristofferjay (CC BY-SA 3.0)
Figure 49. Pilot boarding ship ........................................................................ 77
Figure 50. Ship and cranes in harbour, Rotterdam ..................................................... 78
Figure 51. Grain transfer from ship to shore ............................................................. 79
    Photograph courtesy of The Bühler Group (www.buhlergroup.com)
Figure 52. Vopak Westpoort terminal ................................................................. 79
  Photograph courtesy of Vopak (www.vopak.com)
Figure 53. Product tanker terminal ................................................................. 80
  Photograph courtesy of Nigel Draffin
Figure 54. Very large crude carrier (VLCC) ..................................................... 80
  Photograph courtesy of Nigel Draffin
Figure 55. USS Carl Vinson Battle Group conducts a replenishment at sea (RAS) in the Western Pacific Ocean ....................................................... 81
  Photograph courtesy of US Navy (Photographer: Dustin Howell)
Figure 56. Graving dock ................................................................................. 83
  Photograph courtesy of Nigel Draffin
Figure 57. Flooding a graving dock after painting the hull of the USS Kearsage ........ 83
  Photograph courtesy of the US Navy
Figure 58. Fishing vessel on the Cape Town synchrolift dock ............................. 84
  Photograph courtesy of Nigel Draffin
Figure 59. Bunker barge .................................................................................. 85
  Photograph courtesy of Nigel Draffin
Figure 60. Tug ................................................................................................. 86
  Photograph courtesy of Nigel Draffin
Figure 61. Trailing suction dredger Geopotes 14 .............................................. 87
  Photograph courtesy of Hdek (CC BY-SA 3.0)
Figure 62. Barge/container carrier in floating dry dock at Hamburg ....................... 87
  Photograph courtesy of GH (CC BY 2.0)
Figure 63. Big floating crane ........................................................................... 88
  Photograph courtesy of Nigel Draffin
Figure 64. Giant floating crane in Japan ............................................................ 89
  Photograph courtesy of Tom Jervis (CC BY 2.0)
Figure 65. Canal lock ..................................................................................... 90
Figure 66. Container ship Hanjin Kaohsiung in transit ......................................... 93
  Photograph courtesy of Daniel Csörföly
Figure 67. USS Dwight D Eisenhower aircraft carrier transiting the Suez Canal ....... 94
Figure 68. Miraflores locks on the Panama Canal .............................................. 95
  Photograph courtesy of Dozenist (CC BY-SA 3.0)
Figure 69. Ro-Ro Tourcoing transiting Miraflores locks ..................................... 96
  Photograph courtesy of Dozenist (CC BY-SA 3.0)
Figure 70. Container ship Anna Sirkka entering the Kiel Canal .......................... 97
  Photograph courtesy of Robert Cutts (CC BY-SA 2.0)
Figure 71. Kiel Canal ..................................................................................... 97
Figure 72. Example breakdown of vessel owner’s fixed operating costs ................. 107
Figure 73. MAN B & W G60 ME-C 6 cylinder engine ....................................... 114
  Photograph courtesy of MAN Diesel & Turbo (www.mandieselturbo.com)
Figure 74. A five-bladed propeller ................................................................. 115
  Photograph courtesy of Nigel Draffin
Figure 75. Rudder and controllable pitch propeller .......................................... 116
  Photograph courtesy of Nigel Draffin
SHIPPING

Figure 76. Hydraulic steering gear ................................................................. 117

Photograph courtesy of Nigel Draffin

Figure 77. Azimuthing thrusters before installation in a ship ......................... 117

Photograph courtesy of Kovako-1 (CCO 1.0)

Figure 78. Water jet propulsion ................................................................. 118

Image courtesy of Rolls-Royce plc (www.rolls-royce.com)

Figure 79. Water plane ........................................................................ 120

Figure 80. Block coefficient .................................................................. 120

Figure 81. 300-tonne gantry crane with double trolley for ship building .......... 124

Photograph courtesy of Encore Cranes (www.encorecranes.com)

Figure 82. Ship breaking ....................................................................... 125

Photograph courtesy of Maro Kouri 2010 & Shipbreaking Platform
(www.shipbreakingplatform.org)

Figure 83. Salvage operation to recover the Tricolor .................................. 133

Photograph courtesy of DEME Group (www.deme-group.com)

Figure 84. Costa Concordia with caissons installed on the port side .......... 134

Photograph courtesy of Isjc 99 (CY BY-SA 3.0)