BRIDGE WATCHKEEPING

Third edition

Published by

The Nautical Institute

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Numerous watchkeeping officers on vessels I have assessed over the last four years
The book review team

Foreword

by **Captain Yves Vandenborn FNI**
Director of Loss Prevention at the Standard Club

It is not the ship so much as the skilful sailing that assures the prosperous voyage
George William Curtis (1824-1892)

This book is all about best practice in bridge watchkeeping and, as Director of Loss Prevention at a major P&I club, I fully support it. Navigation accidents are one of the biggest, yet most avoidable, burdens on the shipping industry, often causing irreparable damage to people, property and the environment. Between 2015 and 2020 more than half (58%) of marine liability claims over $10m (ie those pooled by the International Group of P&I Clubs) were navigation-related.

Our analysis shows human error as the primary cause of these 71 incidents, ranging from pilot problems and poor passage planning to excessive reliance on electronic equipment. I believe most of these accidents could have been prevented if the bridge teams had embraced the best practices set out in this book.

As the book says, best practice watchkeeping includes being responsible for safe navigation even when a pilot is on the bridge. A 2020 International Group study of pilotage incidents between 1999 and 2019 showed these happen once a week and over that period the average cost of each incident increased from $1.7m to $4.9m. Nearly all were preventable collisions with fixed and floating objects and other ships.

Best practice watchkeeping is rightly extended in this book to health and wellbeing, something I care about passionately as it directly affects safety. Reduced manning levels, rapid port turnarounds and unduly long periods at sea can all lead to fatigue. Good watchkeepers understand the importance of sleep, diet and exercise and the impact these have on their ability to carry out their day-to-day duties safely and effectively.

Perhaps the most important best practice watchkeeping message to note here is: *never rely on a single source of information.* Despite the dazzling array of technology on modern ships, good watchkeepers should never forget the traditional navigation techniques.

In summary, good watchkeeping protects people, property and the environment. While ships may be financially protected for navigation incidents through their P&I clubs, human suffering and reputational damage cannot be undone. Considering today's difficult economic environment, it is in all seafarers' interest to keep P&I costs as low as possible to ensure the long-term prosperity of shipping.

June 2020

Foreword

by **Captain Peter Boyle MA CMMar FNI**

The late Wing Commander E W Anderson OBE DFC AFC RAF FRIN, a former President of The Royal Institute of Navigation, defined navigation as "the business of conducting a craft as it moves about its ways". From this we can say that the practice of bridge watchkeeping ensures vessels navigate safely from berth to berth.

This is, of course, a very simplistic way of stating the practice. The distance between berths can be very short, perhaps a ship's length, or halfway around the world. The aim of the practice of navigation is to proceed from berth to berth in a safe and timely manner following a planned procedure. It must not be haphazard. Whether the berth-to-berth passage is long or short the same principles apply – professionalism, conscientiousness and attention to detail. Nothing less than navigation excellence is required from the bridge watchkeeper. This expertise guards against risks which may occur and which are often the forerunner of catastrophe.

Circumstances may vary; the watchkeeper may be part of the bridge team which includes the local pilot or they may be the only officer in the middle watch on a transpacific crossing. Whatever the circumstances, conscientious attention to navigation practice is essential.

Today's navigator is the custodian of a proud heritage. Over centuries, the arts of Polynesian and Viking navigators have developed into the scientific and technological methods of today. The competent professional must have the skills to navigate independently of external inputs.

To achieve this, a complete knowledge of astronomical navigation using sextant, time and tables is essential. The development of e-navigation has relieved the navigator of the requirement of making long, and sometime tedious, calculations. Pilotage has improved and the precision of GPS enables navigation to be carried out to much closer tolerances. This progress tends to concentrate shipping in some areas, so a greater focus on avoiding collision is required. GPS may cease to function for political or military reasons, as well as due to technical failure. It cannot be overstated that the ability to navigate independently of external inputs is an essential ability of the professional.

The bridge watchkeeping officer has many responsibilities, among which are communications and safety. Navigation is, however, the epitome of this professionalism; the safe departure, transit and arrival of a ship in a timely manner is the aim of navigation. A careful reading and study of this book will give the junior navigating officer a very firm professional foundation. Human resource gurus tell us repeatedly that complacency is a cause of failure in many critical situations. Perhaps more senior officers will also find it advantageous to dip into the book to refresh their memories on how things should be done.

The criteria have not changed. It is incumbent on senior officers to support, mentor and motivate junior officers to be the best that they can be. Company head office departments should be encouraging and supportive to achieve the same ends.

Contents

Bridge Watchkeeping

List of abbreviations

AIS	automatic identification system
ARPA	automatic radar plotting aid
AUKC	depth of water under the keel at any time
BCR	bow crossing range
BNWAS	bridge navigational watch alarm system
BRM	bridge resource management
BWC	bridge watch condition
CATZOC	category zone of confidence
CEC	Certificate of Equivalent Competency
CFR	Code of Federal Regulations (USA)
Colregs	Collision Regulations
con	navigational conduct of the vessel
CPA	closest point of approach
DGNSS	differential global navigation satellite system
DP	dynamic positioning
DR	dead reckoning
DSC	digital selective calling
EBL	electronic bearing line
ECM	emergency contingency manual
ECR	engine control room
EEBD	emergency escape breathing device
EOOW	engineer officer of the watch
EOP or EOSP	end of passage or end of sea passage
EP	estimated position
EPIRB	emergency position indicating radio beacon
F&A	forward and aft
FAOP	full away on sea passage
FFE	firefighting equipment

FWE	finished with engines
GLONASS	Global Navigation Satellite System
GM	metacentric height
GMDSS	Global Maritime Distress and Safety System
GNSS	global navigation satellite system
GPS	Global Positioning System
HDOP	horizontal dilution of precision
HRU	hydrostatic release unit
ICS	International Chamber of Shipping
ILO	International Labour Organization
IMO	International Maritime Organization
IMPA	International Maritime Pilots' Association
ISM	(IMO) International Safety Management Code
LOP	line of position
LSA	lifesaving appliances
MARPOL	(IMO) International Convention for the Prevention of Pollution from Ships
MCR	maximum continuous rating
ME	main engine
MF	medium frequency
MLC	Maritime Labour Convention 2006
MOB	man overboard
MPEX	Master/pilot exchange
MSI	marine safety information
MUKC	minimum underkeel clearance
NAVTEX	navigation telex
NFU	non-follow-up
NGO	non-governmental organisation
NUC	not under command
OCA	off-course alarm
OHC	overhead clearance
OOW	officer of the watch

PM	performance monitor
PPU	portable pilot unit
PSC	port state control
PSSA	particularly sensitive sea area
PVF	position sensor integrity verification fix
RO	radar overlay
SAR	search and rescue
SART	search and rescue transponder
SBE	standby engines
SEA	Seafarer's Employment Agreement
SES	satellite Earth station
SMCP	standard marine communications phrases
SMS	safety management system
SOLAS	(IMO) International Convention for the Safety of Life at Sea
SPM	single-point mooring
STCW	Standards of Training, Certification and Watchkeeping
SWL	safe working load
TCPA	time to closest point of approach
TMC	transmitting magnetic compass
TSS	traffic separation scheme
UKC	under-keel clearance
UMS	unmanned machinery space
VDR	voyage data recorder
VHF	very high frequency
VRM	variable range marker
VTS	vessel traffic service
WP	waypoint
Wx	weather observation
XTD	cross track distance
XTE	cross track error
XTL	cross track limit

Introduction

Congratulations! You have gained your OOW licence and are about to embark on your professional career, which we at The Nautical Institute hope you will find satisfying and rewarding. This book aims to guide you through all the steps and processes to help you learn to serve as a competent bridge watchkeeping officer.

Before we start, it might be useful to discuss what a ship does and the most important activities or disciplines needed to operate it. These are as follows:

- Navigation
- Stability and stress
- Loading, discharging and care of cargo
- Deck and cargo operations
- Ballasting operations
- Anchoring and mooring
- Marine engineering
- Maintenance and repairs
- Bunkering
- Taking and receiving stores and spare parts
- Administration
- Communications.

Encompassing all of them are safety and pollution prevention.

A ship operates in three phases. The first is loading or discharging cargo and/or embarking and disembarking passengers. Second, when arriving or leaving port it potentially faces dangers such as shallow water, underwater hazards and traffic with close passing distances from other vessels. In the third phase the ship will be in the open sea, making a coastal or deepsea passage. Additionally, the ship many need to enter port to undertake repairs, which could include dry docking.

At each phase the main priority will change. For example, navigation will be the most important task when the ship is leaving port or at sea. Once in port cargo operations, combined with taking on stores, will be foremost. For those in the engine department, the priority in port will be main engine maintenance and taking on bunkers, whereas at sea their main tasks will be monitoring and operation of the machinery plant.

On average a ship spends 70% of its time at sea so navigation is the most important activity undertaken in ship operations. Make a navigation mistake or forget to do something and the consequences can be catastrophic.

Accidents can occur when crews switch from one phase to another. As an OOW you will be involved in operations both in port and at sea, making a transfer from keeping watch on deck to keeping watch on the bridge. Make sure one task is completed before you start the next. Never rush!

Safe navigation is the safe conduct of the ship from one berth, which includes an anchorage, to another. At the heart of safe navigation is bridge watchkeeping. But it is not as simple as that: you will learn that there are other disciplines and duties to be undertaken, which are described in the following chapters.

Best of luck and above all safe voyages.

A note on using the book

Bridge watchkeeping consists of many independent activities and disciplines that together ensure safe navigation of the vessel. Some of these activities are performed on every watch at sea, some infrequently. The activities for the different operating conditions, both internal and external, are explained throughout the book. In the final chapter these activities are brought together so you can understand how navigation watches can be performed appropriately.

Most of the book is written assuming work on a conventional cargo ship crewed by three qualified OOWs – the Chief Officer (CO) and second and third officers. There are many variations to this crewing system. For instance, an extra OOW may be carried, allowing the CO to be a day worker. Cadets and trainee officers may be carried and on some large passenger ships there could be two OOWs on each bridge watch. In these cases, the tasks and responsibilities described in the book will be divided.

A professional approach

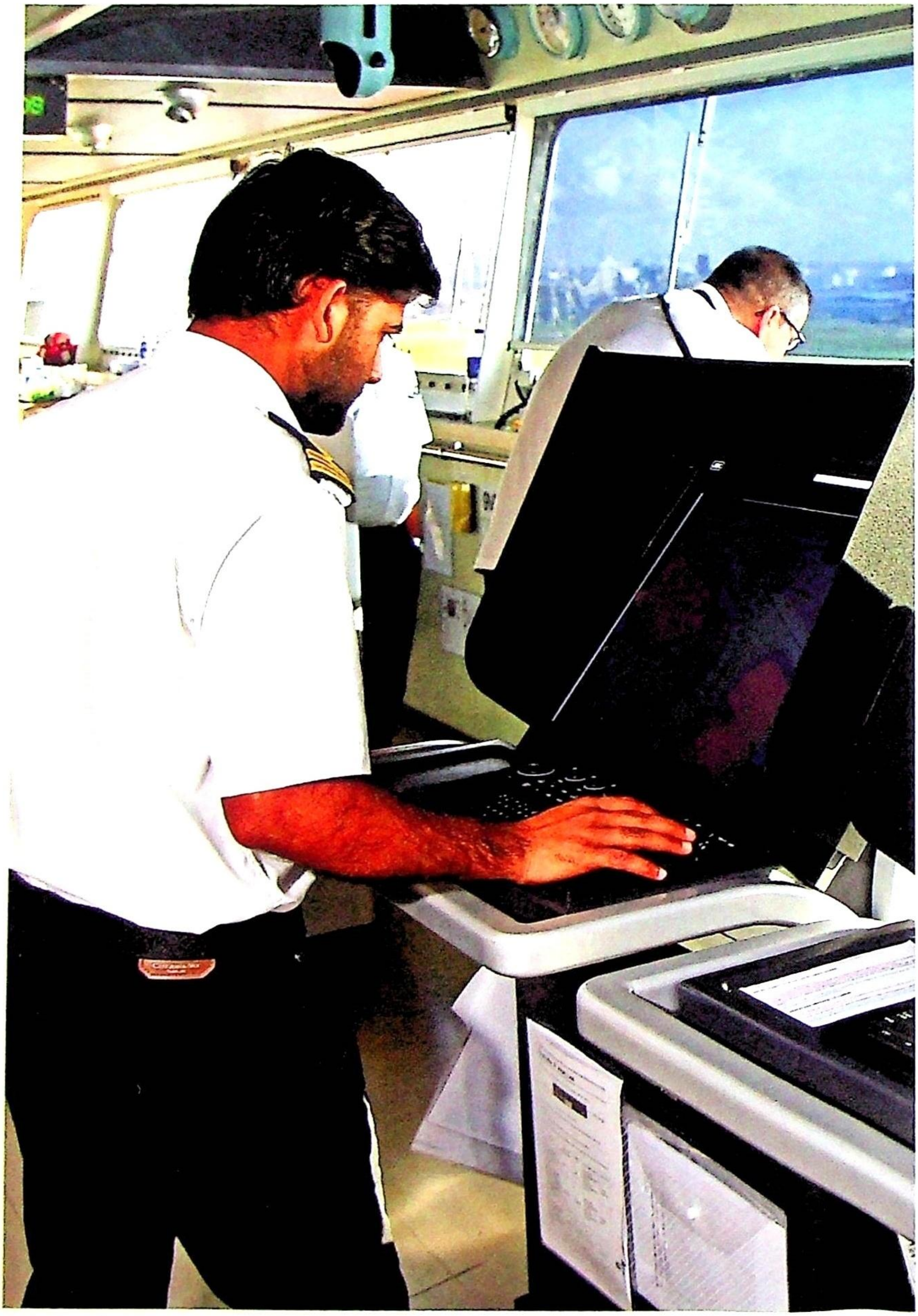
All professionals refer to various text books and publications throughout their careers. Doctors consult medical publications, lawyers refer to legal books, civil engineers to books on construction and navigators to books on navigation. There may be complete libraries in hospitals, legal chambers or on ships' bridges, but many professionals invest in their own copies of the main reference books. This is to be recommended for ships' officers. Key texts on the operation of equipment such as ECDIS, radar, AIS or other elements of navigation are always a good investment for a navigating officer.

The Nautical Institute publishes many books relevant to navigation, which are written and peer-reviewed by professionals. These were used as sources of information for this publication. The Institute's monthly magazine, *Seaways*, contains articles from members and other experts that enable readers to keep abreast of developments in best practice. The magazine – free to members – is a huge benefit of becoming a member of The Nautical Institute.

Nautical Institute branches hold regular meetings on subjects of professional interest. Membership therefore enables you to meet other professionals around the world and at your local branch. Many meetings are held online, so all members, regardless of location, can benefit from the knowledge and experience being shared. The great value of attending physical meetings is the ability to network with other professionals.

Members of The Nautical Institute gain the recognition of belonging to a professional body that works to improve best practice through the Institute's NGO seat at the IMO. All members benefit from discounts on the Institute's publications.

On the Institute's website – www.nautinst.org – you can find more details about membership, worldwide branch contacts and the NI's full range of publications. The website is also the place to pick up your free copy of *The Navigator*, published jointly with the Royal Institute of Navigation.



Chapter 1

Before leaving home

Rules and regulations governing watchkeeping

Just about everything to do with a ship and the people who operate it is governed by a series of regulations. These are:

- International
- National
- Regional
- Local
- Industry sector
- Company.

Most international regulations are laid down by the IMO and are set out in conventions, sometimes called the pillars of the IMO. Conventions are usually known by their initials and the main ones are:

- SOLAS – International Convention for the Safety of Life at Sea
- STCW – Standards of Training, Certification and Watchkeeping
- MARPOL – International Convention for the Prevention of Pollution from Ships.

The main maritime regulation from the International Labour Organization (ILO) is the MLC – the Maritime Labour Convention 2006.

The national laws that apply to you are those of the flag state of the ship. The flag state incorporates into its national law those IMO conventions it has approved. From that stage it is compulsory to follow them. Each flag state periodically inspects its flagged vessels to confirm that they are adhering to all regulations.

Some coastal states, individually or regionally, pass legislation that applies to ships operating in their waters. These are generally aimed at protecting that country's resources. Local regulations also cover ports and may include rules governing the speed and anchoring of ships within port limits. Coastal states verify that international, regional and national laws are being followed by carrying out what are known as port state control (PSC) inspections.

Different sectors of the industry have also developed special rules governing safety and environmental protection. For example, tankers and terminals must comply with rules produced by the oil and gas industry.

Finally, companies issue rules to be followed by all employees operating their ships.

Your obligation to follow these rules is contained in your MLC contract of employment, and in some cases you must sign to confirm you will observe all these regulations. You will also sign the Master's Standing Orders (see later), which also require you to confirm that you will follow these rules.

To aid understanding of the many of the rules that cover bridge watchkeeping, companies draw up their own onboard bridge watchkeeping procedures in the safety management system (SMS) in simple format.

Where do you fit in?

Responsibility and authority on board ship can be divided into three main levels:

- Management
- Operational
- Support.

The management level consists of Master, CO, Chief and Second Engineers. On passenger ships the Staff Captain, Safety Officer, Staff Chief Engineer and Hotel Engineer are present in addition. The operational level consists of all other officers such as second and third officers, third and fourth engineers and, where carried, electrical officers. The support level is made up of the crew: ABs and OS on deck; motormen, fitters and oilers in the engine room; cook and messman in the galley.

Management level officers take higher level decisions and issue instructions to both the operational level officers and support level crew members. Operational level officers will take decisions within the guidelines provided by the SMS and management level instructions and issue instructions to the crew. Support level crew are responsible for carrying out instructions issued to them by management and operational level officers and reporting back to them when tasks are completed.

As an OOW you will have duties in port and at sea. During both your time on watch and outside your watchkeeping duties you will work with ratings and give them instructions or orders. You will also receive orders from senior officers and the Master. You will have to manage the activities of your subordinates and lead them in specific tasks. They will look to you for leadership.

The key navigation activities undertaken on the bridge during a watch at sea are:

- Collision avoidance
- Executing and monitoring the passage plan
- Steering the ship
- Lookout.

The person who issues all the engine and helm orders to ensure the safe conduct of the ship is said to have the con. When conditions are uncomplicated and the workload is light, either during deepsea or coastal navigation, the OOW will have the con. As the workload increases, they will need the assistance of another officer; in most cases this will be the Master. The senior officer on the bridge will usually assume the con in such circumstances.

The con must never be confused with the word command. Masters never relinquish command of their vessels. They may hand over the con of the vessel to pilots, but they can retake the con at any time, especially if they are not satisfied with a pilot's performance.

IMPORTANT
Know and understand the difference between con and command.

Workload

The navigation workload may increase for various reasons. Navigation increases in complexity with the number and proximity of fixed navigation hazards such as shoal patches, offshore structures, routes near small islands and traffic separation schemes (TSS). There may be several turns to implement in the passage plan, or increased risk of collision from heavy traffic or concentrations of fishing vessels.

Meteorological conditions can have severe effects. The weather may deteriorate so you face reduced visibility. This will make small targets difficult to detect. A deterioration in the weather could also make it difficult to maintain course.

The navigation workload will also increase if you are responding to distress calls or participating in search and rescue (SAR).

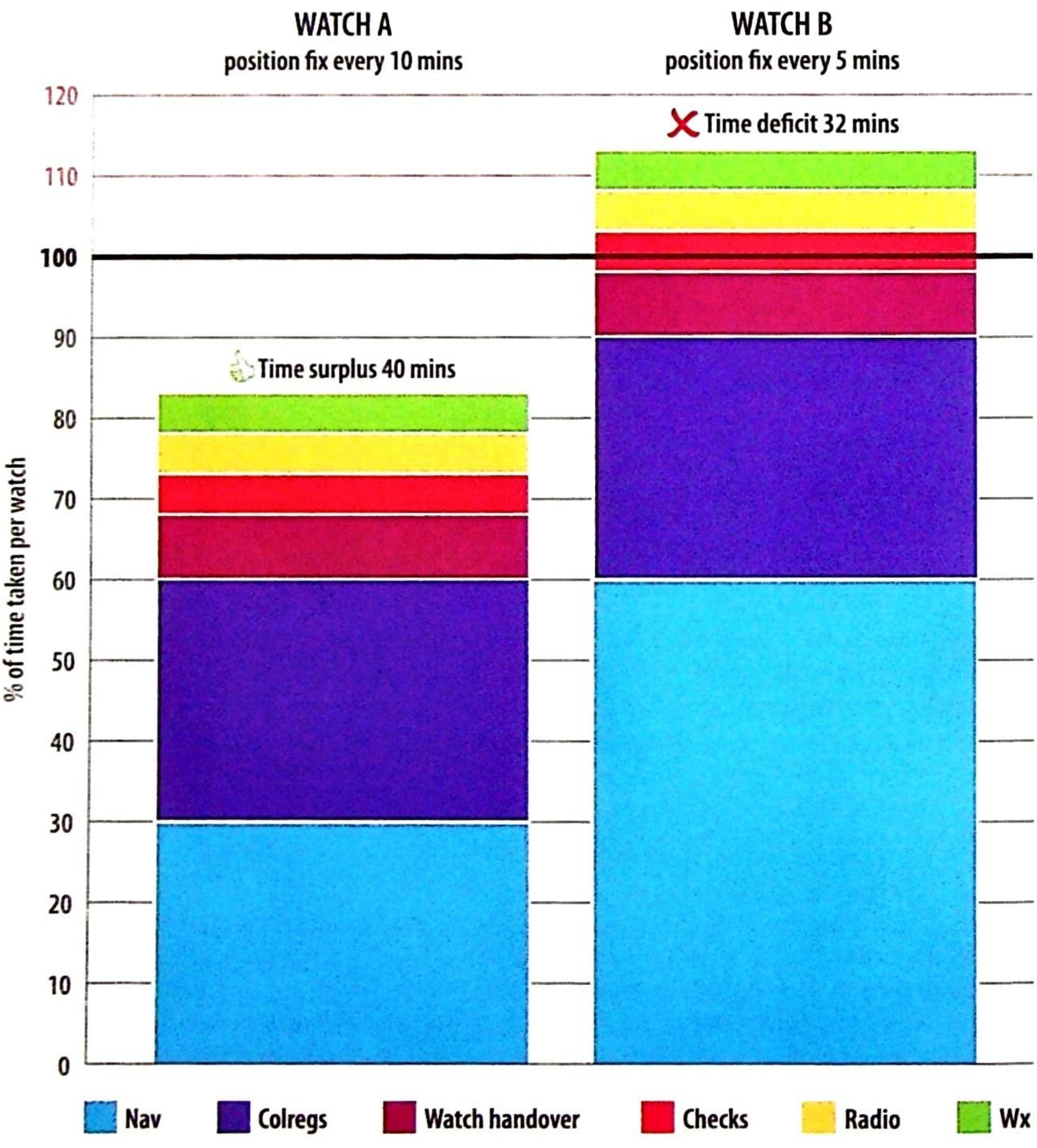
There will be occasions when a pilot must be on board the ship and incorporated into the bridge team. Usually, they will be handed the con. The Master remains responsible for the safe navigation of the ship and will thus adopt an overall monitoring role – in some companies known as Director of Navigation.

REMEMBER
The pilot may have the con but the Master keeps command.

Working conditions on the bridge can also increase workload if the OOW needs to move around the wheelhouse to plot the ship's position, read marine safety information (MSI) messages and view the GPS receiver etc. The workload will be less on modern ships with integrated systems and workstations with multiple functions. In the absence of an integrated bridge, situational awareness can be lost, especially at night, and assistance will be required to maintain a safe watch.

The table here shows how the workload can increase as a result of simple changes in the necessary activities. Consider the amount of time taken by plotting the ship's position every 10 minutes. If it takes 3 minutes for each fix from taking the first bearing to plotting on the chart, this adds up to 18 minutes every hour or 72 minutes every four-hour watch.

The left-hand column shows a surplus when the watchkeeper is on a four-hour watch undertaking many watchkeeping activities including applying Collision Regulations (Colregs), watch handover, equipment checks, GMDSS, weather observation (Wx) and forecasts. It also includes recording navigation activities and additional work. The right-hand column shows a 32-minute deficit, representing 13% of the watch.



Watchkeeping occupied time. Left-hand column shows a time surplus; right-hand column shows a time deficit

If the position must be fixed every 5 minutes, the task becomes more time-consuming, occupying 36 minutes every hour or 144 minutes every four-hour watch. The next table illustrates very clearly that the OOW will rapidly become overloaded and will not have enough time to attend to all tasks.

The surplus of 40 minutes in the first column has now become a deficit of 32 minutes, as shown in the second column. A similar situation would arise if the ship encountered heavy and continuous traffic that required more time to be dedicated to collision avoidance. As the workload reaches 100% then it is time to call for assistance or, as it is now termed, to increase the bridge watch condition (BWC).

Different navigation circumstances call for different BWC and the watchkeeping duties each person undertakes will also change as this table shows.

Navigation conditions	BWC	Director	Con	Collision avoidance	PaxPlan	Lookout	Helm
Deepsea	1		OOW	OOW	OOW	Rating	Auto
Deepsea	2		Master	Master	OOW	Rating	AB
Coastal 1	1		OOW	OOW	OOW	Rating	Auto
Coastal 2	2		Master	Master	OOW	Rating	AB
Coastal 3	3		Master	Master	Senior OOW	Rating	AB
Pilotage	P	Master	Pilot	OOW	OOW	Rating	AB

Basic navigation conditions and key duties

BWC 1

Applicable in deepsea and coastal waters with no circumstances leading to increased workload.

OOW
Undertakes the con, collision avoidance and passage plan execution and monitoring duties.

Lookout
Maintains a lookout and normal duties as outlined in this book.

BWC 2

Applicable in deepsea or coastal waters if a deterioration in the weather or visibility or encounters with dense traffic increases the workload.

The con officer
The senior of the two officers. Usually this would be the Master, but the responsibility should be split between the Master and the CO if these conditions are prolonged.

Watch coordinator and supervisor
Responsible for collision avoidance. Issues orders to adjust course and speed to ensure safe navigation.

Passage plan execution and monitoring officer – OOW
Position course and speed monitoring, position plotting, track adherence. Provides radar plotting and collision information to the con officer.
Records events as set out in this book and coordinates bridge communications.
Acknowledges the con officer's helm and engine orders and ensures they are executed.

Lookout
Normal lookout duties.

Helmsman
If required.

BWC 3

Applicable where intense navigation activity is experienced such as dense traffic coupled with complex navigation demands.

Master
Has the con. The Master is the watch coordinator and supervisor.
Adjusts the vessel's course and speed to ensure safe navigation.
Ensures teamwork and open communication between all members of bridge team.

Collision avoidance officer (senior OOW)
Monitors the automatic radar plotting aid (ARPA), AIS and visual situation for early target detection, target confirmation and risk of collision.
Operates the automatic radar plotting aid for closest point of approach (CPA) information and trial manoeuvres.
Monitors the AIS for early target detection, target confirmation and information.
Ensures lookout is alert, effective lookout is being maintained and positive reporting.
Provides collision avoidance information to the con officer and supporting navigation information to the position monitoring officer.

Position monitoring officer (OOW)
Monitors the vessel's track and ensures adherence to the passage plan.

Regularly updates the con officer on the ship's progress, the cross track error, distance to the alteration of course point and wheel over position and proximity of nearest navigation danger.
Also responsible for general communication.

Lookout
Normal lookout duties.

Helmsman
Steers the ship in manual mode.

BWC 2P or 3P

Applicable during pilotage.

Master – Director of Navigation
Closely monitors the pilot's instructions and actions and ensures navigation safety.
Ensures the bridge team adopts positive reporting.
Ensures the pilot is supported with the information they require and that their orders are carried out.
Ready to intervene and retake the con should the pilot not perform as required.

Con officer – pilot
Issues orders to adjust course and speed to ensure safe navigation.
Supported by bridge team.

Collision avoidance/passage plan execution and monitoring officer – OOW
Position, course and speed monitoring, position plotting, track adherence.
Provides radar plotting and collision information to the con officer (pilot).
Records events as set out in this book and coordinates bridge communications.
Acknowledges the con officer's helm and engine orders and ensures they are executed.

Lookout
Normal lookout duties.

Helmsman
Steers the ship manually.

As the bridge watchkeeping OOW you will adopt various roles, which can be classified as:
- Management level leader
- Operational level team member
- Support level team member.

As a management level leader at sea on watch you will be fully responsible for the safety of the ship, reporting to the Master according to their Standing Orders. As OOW in the normal BWC 1 (page 9) you will be fully in charge of the watch and responsible for the ship in accordance with the SMS and Master's Standing Orders. You will be expected to give orders to the bridge team (the lookout(s) and helmsman) at the time. They will look to the OOW for guidance and leadership.

As an operational level team member, you will issue orders to your watchkeeping crew members or, when required, other crew members – for example to prevent crew going on deck. There will be other times when you are allocated specific jobs, as set out on the muster list, to carry out either alone or with another crew member, for example during emergencies. As a team member of the bridge watch (usually under BWC 2, page 9, when a senior officer takes the con) you will share information with the senior officer and respond to their requests.

As a support level team member, you will support other senior officers that are on the bridge, for example in BWC 3, on page 10.

As the OOW bridge watchkeeper, you will be expected to lead your team and issue them with orders and instructions. You must always ensure effective two-way communication with your team members.

Calling the Master

The Master of a ship is required by law to issue Standing Orders and indicate the times and circumstances when they are to be called. Some companies specify the circumstances that Masters are to be physically present on the bridge. Most Masters add their own additional requirements covering when they should be called. The Master will impress on junior officers that they should never be worried about doing this.

It is important to understand that the Master wants you to call them when they are needed. They will then come to the bridge and at that point they will decide whether to take over the con or support the OOW by their presence. Remember, there will be times when calling the Master is routine and can be shown on the passage plan. There will be other times when you cannot know in advance that you will need to call them when unexpectedly encountering large numbers of fishing vessels or experiencing bad visibility, for instance.

Changing the BWC will usually involve calling the Master unless they specify in their daily orders that the backup OOW should be called.

Your health and wellbeing on board

To be able to perform an effective bridge watch you need to be physically fit and mentally alert and it is your responsibility alone to ensure this. The key topics that may influence your physical and mental wellbeing are set out here.

Drugs and alcohol

The adverse effects on safety of drugs and alcohol are well known and it is an international requirement for each ship operating company to have a clear drug and alcohol policy in place on board each ship. Where alcohol is allowed, there will usually be a requirement to abstain from consuming it for a specific period before watch. The OOW should start their watch with zero alcohol content in their bloodstream.

Be aware that many common medications, such as cough medicines, contain alcohol. If you are taking these medications be sure to tell the ship's medical officer. If you bring medication on board the ship, you should bring a doctor's prescription with you and present this to the Master.

REMEMBER
Penalties for carrying and using illegal substances are severe.

All of this will be covered by the company's drug and alcohol policy, which you will be required to sign. This will probably include a provision that you accept random testing. If the ship is involved in a maritime accident such as a collision, the authorities involved will require you to undergo a test.

Fatigue

The effects of fatigue can be worse than the effects of alcohol. Whereas the effects of alcohol can be prevented, it isn't always possible to avoid the effects of fatigue – after all human beings are not machines and cannot operate a switch to go to sleep immediately. It is, however, a misdemeanour not to report that you are fatigued when going on duty.

Fatigue is both a simple and a complicated subject. It is simple in that it is caused by lack of sleep; it is complex because there are many root causes of inadequate sleep. The average adult human being requires between 6.5 and 8 hours of sleep in every 24 hours. Sleep should be in an environment that is free from noise, motion and vibration. It will be of better quality if caffeine, alcohol and heavy meals are avoided immediately before going to bed. Ideally avoid blue light where you are sleeping and limit or avoid computer activities before bed.

REMEMBER
Avoid computer activities, blue light, caffeine, alcohol and heavy meals immediately before going to bed.

Even on a ship operating the 4 hours on and 8 hours off regime it can be very difficult for watchkeepers to obtain basic quality sleep. The total might be achieved in two periods, but the rest quality will not be adequate. In these circumstances a person will develop sleep debt over time. Eventually this sleep debt builds up so much that the person will just fall asleep wherever they are.

No spreadsheet or computer program can resolve fatigue. These tools merely show whether a regulation has been followed. A seafarer who has complied with all the rules and had the requisite time off to rest may nevertheless have been unable to sleep. As a result, they are still fatigued.

You need to have personal discipline. Any watchkeeper who realises they are fatigued must call their standby to take over their duty. Some companies have fatigue mitigation procedures and place an extra officer on board ships with busy schedules. Or they may require the daywork CO to take occasional watches to give watchkeepers a chance to recover from sleep debt.

Masters take an occasional watch and use this to train a cadet or relieve the CO after busy cargo operations. All these strategies allow watchkeepers to recover from sleep debt. When circumstances require the Master to be on the bridge for a prolonged period, they will usually split this responsibility with the CO.

IMPORTANT
If you are fatigued, call your standby to take over duty.

Physical wellbeing

An OOW can only be alert and make correct decisions when they are fit and well. This means undertaking regular exercise, maintaining a balanced diet and avoiding injuries. Simple slips, trips and falls account for many injuries aboard ship. Remember the old saying, *"one hand for the ship and one hand for yourself"*.

Most officers get a lot of natural exercise on board through their non-watchkeeping duties; just using the stairs up and down to the bridge can provide this. Alternatives are a jog around the decks on large tankers and bulk carriers or using the gym, where provided.

Ships operate in harsh climate extremes with temperatures ranging from 50°C to -30°C. Extreme conditions can lead to physical exhaustion. Be aware that heat stroke or hypothermia can affect you very quickly.

A healthy diet is essential. Items to avoid are fats, salt and sugar, as excessive consumption can lead to serious health conditions such as heart and lung disease. Diet also has a big role to play in the onset of diabetes. The condition has become far more common in recent years and can lead to life-changing complications.

Mental wellbeing

Seafarers' mental health and wellbeing is receiving far more attention these days. Poor mental health can negatively affect how people behave, work and look after themselves.

Seafaring has been recognised as a high-risk profession in terms of mental health. The closely confined environment, limited social interaction resulting from reduced manning, feelings of total isolation, the lack of immediate assistance and numerous stress-inducing factors can all contribute to depression in seafarers.

If we become physically unwell we can seek medical help relatively easily – by visiting the doctor or, when aboard ship, by notifying the ship's medical officer. However, there is a stigma attached to mental health issues. The fear of being identified as mentally unwell can make it difficult even to talk to family members about the subject. On board ship this reticence can be much worse.

Some companies offer confidential support. This may be through a system of onboard assistance or a link to responsible people in offices ashore including company doctors.

For totally independent help, the International Seafarers' Welfare and Assistance Network (ISWAN), which works to promote the welfare of seafarers and their families, offers a service called SeafarerHelp. It is a free, confidential and multilingual helpline for seafarers and their families available 24 hours a day, 365 days a year. For more details, see www.seafarerswelfare.org/our-work/seafarerhelp.

Documents you need to bring with you

One of the most important regulations to affect you throughout your seagoing career is the IMO's STCW which states that all OOWs must be qualified according to the standards set out in Chapter II Section A-II/1. A PSC inspector may need to check this once you are on board ship, so you MUST carry your OOW licence (CoC) and relevant STCW training certificates with you.

In addition, if you sail on a ship whose flag (nationality) is not the same as your own, you must apply for a Certificate of Equivalent Competency (CEC) from that flag state. Sometimes this flag state licence takes time to arrange, in which case you will be given an official document (sometimes called a Certificate of Receipt or COR) showing that you have applied for a flag state licence.

You will also need to take with you documentation and certificates relating to:

- Your copy of the contract of employment, Seafarer's Employment Agreement (SEA) (MLC 2006)
- GMDSS – national and flag state (or your COR if you do not have the flag state endorsement)
- Seafarer's medical examination certificate
- ECDIS generic certificate
- ECDIS type-specific training (if you have undergone that) or ECDIS type-specific familiarisation
- Bridge resource management (BRM) certificate

- Other relevant training certificates for:
  - Radar
  - ARPA
  - Simulator
- Seaman's book (seaman's discharge book)
- Passport
- DP (dynamic positioning) logbook where required.

IMPORTANT
Before you leave home take a good quality photocopy of each of your certificates and leave these copies at home in a safe place.

As well as making copies of your certificates, it is recommended you take with you a scanned copy of your certificates, or you can take a clearly legible photograph of them. You can store these files on a USB drive, a smartphone, tablet or notebook computer in case one of your certificates is mislaid on board, as occasionally happens. Always check that your certificates are valid for the expected duration of your contract on board ship.

Most crewing managers will check that you have all the certificates before you leave home for the ship and some will provide you with a zipped folder for their safe keeping.

Chapter 2

First principles

The fundamental principles of bridge watchkeeping

Bridge watchkeeping consists of many principles, most of which are concerned with safe navigation. Safe navigation depends on following good bridge watchkeeping practices. These practices have been developed over many years and consist of basics or first principles, which are used at least once every watch, others that may be used many times in a single watch and some that are used less frequently. There are some that you may never use in your entire seagoing career. Many regulations have been developed over time to ensure navigation is carried out safely. As new navigation instruments, equipment and techniques have been developed, these in turn have created new first principles and at times required a modification or cancellation of older ones.

IMPORTANT

According to Part A, Chapter VIII Part 4 paragraph 10 of STCW:

Under the master's general direction the officers of the navigation watch are responsible for navigating the ship safely during their periods of duty, when they will be particularly concerned with avoiding collision and stranding.

A typical example of these first principles are the Colregs and the development of radar. In the past, collision avoidance in fog depended heavily on the use of sound signals, and if the sound signal of another vessel was heard without being sighted then the engines were stopped and the ship carefully manoeuvred until the danger of collision had passed. The introduction of radar enabled ships to see other ships in bad visibility. However, just looking at a radar was not enough, so the technique of plotting was introduced. As the years progressed, more was learned about radar and its disadvantages. Cautions were written into best practices to ensure improper use of radar did not cause collisions.

STCW is quite clear about the place of duty in Part A, Chapter 8 paragraphs 24.1 and 24.2 and the Manila Amendment regulation VIII/2 2.1. This states that it is of "paramount importance" that every OOW understands that their place of duty is on the bridge whenever the ship is underway or at anchor. In other words, the OOW shall be physically on the bridge and never leave it unattended at any time while the ship is underway or at anchor.

Rules alone, however, are not enough to avoid collisions. They need to be supplemented by other first principles and the most important among these is lookout. This term seems straightforward. Look uses the sense of sight. The Colregs, however, state that lookout shall be made by all available means – by sight and hearing. This could appear a little confusing to the newcomer, who may well ask: how can I keep a lookout with my ears? It is important to understand that "lookout" includes:

- Sight – visual
- Hearing – aural
- AIS – electronic
- Radar – electronic
- VHF – (very high frequency) radio.

Using AIS and radar lookout methods, approaching targets can be identified by name, position or range and bearing. When information is received from more than one source, there needs to be confirmation that it refers to the same target. Continuous monitoring is required to ensure targets never pose a threat until they are past and clear of your own ship. More details are contained in the section on avoiding collisions – see page 38.

To avoid running aground, prudent navigators never rely on a single source of information; they check, monitor, control and record. Navigation expert Captain Paul Whyte FNI said:

> *Navigation is not about knowing where you are, but much more about knowing where you should not be. Too often ships end up where they should not be, sometimes with dangerous and hazardous consequences for all in the vicinity.*

IMPORTANT
Never rely on a single source of information – check, monitor, control and record.

To ensure we never run aground, we adopt another first principle – passage planning (see page 89). Before the voyage begins, an intended route is plotted to identify all known dangers and to keep the ship in safe water. To identify safe water you need to take into account the available depth of water, the ship's draught and under-keel clearance (UKC). The minimum UKC is calculated in advance and then applied to the route the ship will follow. It will also be necessary to check for overhead clearance (OHC) if the ship needs to pass under any bridges.

The ship must also keep a safe distance off land, so that if the main engines break down and the ship starts to drift there will be sufficient time to remedy the problem or seek assistance.

In many areas the ship will have to follow a traffic separation scheme (TSS), designed to separate traffic travelling in opposite directions and reduce the possibility of head-on collisions.

Once the route has been planned, it must be executed and monitored. To ensure that the ship follows the intended route and individual tracks, the OOW must plot the ship's position at regular intervals.

Further NI guidance

For the theory behind these principles, you should consult other Nautical Institute publications: *The Admiralty Manual of Navigation Volume 1 – The Principles of Navigation, Radar and AIS, ECDIS and Positioning* and *Bridge Team Management*.

In addition, for regular updates on key topics of navigation, The Nautical Institute publishes a free magazine called *The Navigator* see https://www.nautinst.org/resource-library/publications/navigator.html

Finally, if you want to keep up to date with key issues, then The Nautical Institute's monthly members' magazine *Seaways* is for you. See membership details at the back of the book.

Familiarisation

Before starting work, everyone needs to become familiar with the workplace and the equipment they are to use. This is especially so for bridge watchkeeping. Usually when you join a ship several people will help you with this. The ship's safety officer will explain safety issues, the officer you are to relieve will explain your specific roles in port watchkeeping tasks, the CO will outline department instructions, and the navigator will detail the bridge and navigation roles. At some point before sailing, the Master will give you a copy of their bridge Standing Orders for you to read; you will be asked to sign them as an acknowledgement you have read them and you may be given your own copy. One week later you will be asked to sign them again to indicate you have since fully understood them.

Some companies may require you to sign copies of the International Safety Management Code (ISM) and the safety management system (SMS) manuals which contain detailed company-specific procedures for navigation. It will take you a long time to become fully familiar with the SMS, so make sure you are aware of its location on board when joining the ship.

Familiarisation of bridge watchkeeping can be divided into three parts:
- Physical arrangements of the bridge and wheelhouse
- Navigation and bridge watchkeeping duties covered by the SMS
- Equipment and instruments used for navigation and communications.

Your familiarisation may be supplemented by written notes and diagrams and even video clips. There can be a lot of information to take in during a brief turnaround in port.

IMPORTANT
If in doubt, ask – there is no such thing as a stupid question.

Familiarisation will be dealt with in greater detail in Chapter 3.

Lookout

The subject of lookout is included in two of the major international regulations. These are Colregs and STCW.

Colregs broadly set out the 'when' and 'how' of operations. For instance, rule 5 says that every vessel shall "at all times" maintain a proper lookout by sight, hearing and all available means appropriate in the prevailing circumstances and conditions. From this the expectation is that a full assessment of the situation is made to reduce the risk of collision.

IMPORTANT
The significant expressions in the Colregs rule 5 are "all available means appropriate" and "prevailing circumstances and conditions".

When this rule was written in 1972 detection of other vessels was through sight (visual), hearing (aural) and radar. In fog or restricted visibility, the bridge team had to depend on fog signals and radar, but sometimes radar could not detect small vessels. Great care had to be taken, therefore, because the range at which a fog signal can be heard is only about 2 miles. Wherever possible, visual means were considered the best way to confirm the presence of another vessel. At the time, "all available means" meant, in practice, that you should obtain confirmation from an alternative source. "Prevailing circumstances" meant that if you could not see, then the next best system or systems should be used.

Over time there have been developments to improve lookout and, from 1964 onwards, the American Pilots Association (APA) recommended a uniform system of bridge-to-bridge communications. It is mandatory in US waters to use this, but not recommended elsewhere.

Improvements in radar design led to better target acquisition and ARPA was later installed on most oceangoing ships. Automatic acquisition of targets became possible.

Finally, AIS was introduced, so the list of available means of lookout expanded to:

- Visual – eyesight
- Aural – hearing
- Radar
- VHF
- AIS.

In addition, and to comply with STCW, we must include the echosounder, which can show a reduction in depth below the keel and the risk of possible stranding. However, the echosounder *cannot assist* in avoiding collisions.

Each of these systems for keeping a lookout has its advantages and disadvantages, so OOWs should be aware of the limitations of each. Today it is possible to have multiple means of detecting and confirming the presence of another vessel. This helps prevent making the assumptions set out in Colreg 7c.

It is normal today to use radar as the primary means of lookout in all weathers and confirm the presence of targets by all other means available, which may be visual or AIS. The VHF lookout (listening watch) can best be described as the receipt of information broadcasts from vessel traffic service (VTS) stations. These will include information on vessels restricted in their ability to manoeuvre, vessels constrained by their draught, ships not under command (NUC) and, more recently, fishing vessel concentrations. These messages may be transmitted by the vessels themselves and must not be ignored. Beware of vessels that may be displaying incorrect AIS data, including incorrect static or dynamic data from faulty sensors. Some ships may even display the incorrect navigation lights or shapes – these ships are in contravention of Colregs.

In STCW Part A, Chapter VIII, Regulation 14 the conditions for a proper lookout are set out, referring to rule 5 of the International Regulations for Preventing Collisions at Sea 1972, as amended. A proper lookout is to ensure three main objectives.

The first is to watch for any significant change in the operating environment by maintaining a continuous state of vigilance by sight, hearing and all other available means. This recognises and supports the need for a lookout in Colreg Rule 5.

Second, the lookout needs to appraise the situation and the risk of collision, stranding and other dangers to navigation. Breaking waves may indicate a stranding danger from shallow water. Other dangers may include floating containers, fishing nets or derelict ships.

Third, this part of STCW includes a need to be vigilant about the safety of others by detecting ships or aircraft in distress, shipwrecked persons, wrecks, debris and other hazards to safe navigation. If the lookout believes they have sighted a distress signal they should immediately refer to the rescue signal table, which is required to be displayed on the bridge.

To this list of lookout methods in STCW Part A we must add the echosounder, which warns of the risk of grounding.

STCW Regulation 15

This rule states that the lookout must give full attention to the task of keeping a proper lookout and not be assigned, or undertake, any other duties that could interfere with that task.

STCW Regulation 16

This rule states that the duties of the lookout and the person at the helm are different and the helmsman is not to be considered the lookout except under special circumstances.

It is useful at this stage to consider the capabilities and limitations of each system. No single system is perfect for keeping a lookout, as the lookout capabilities table below shows. It is for this reason that as OOW you should NEVER rely on one system alone but always seek confirmation from all other sources. This practice conforms with "all available means" stated in the Rules.

On modern vessels, all the sources of lookout information are grouped together so that it is possible to glance at or listen to one and then another in quick succession and thereby evaluate the situation constantly. On older vessels, the OOW will have to move around to monitor all sources.

Lookout capabilities	Lookout type					
	Sight	Radar	AIS	Hearing	VHF	Echo-sounder*
Can see or detect targets in poor visibility	✗	✓[1]	✓	✓	✓	
Can see or detect targets in wave troughs	✗	✗	✓	✓	✓	
Can see or detect targets behind obstructions	✗	✗	✓	✓	✓	
Can see or detect targets in precipitation	✗	✗[2]	✓	✓	✓	
Can see or detect targets at long range	✗	✓	✓	✗	✓[3]	
Can see or detect aspect	✓[4]	✓[5]	✗	✗	✗	
Can see target colour	✓[6]	✗	✗	✗	✗	
Can see or detect target day or night	✓[7]	✓	✓	✓	✓	
Provides positive target identification	✗	✗	✓	✗	✗	
Provides target data	✗	✓[8]	✓[9]	✗	✗	
Provides target status	✓	✗	✓	✓[10]	✗	
Provides range	✗	✓	✓	✗	✗	
Provides depth under the keel (UKC) Colreg 6.a.vi and STCW (A8 36)						✓

Table 2.1 – Capabilities of each lookout system

Notes

* In STCW but not a lookout system
[1] In very heavy rain, targets may be obscured on radar
[2] In very heavy rain, especially squalls, targets may be obscured on radar
[3] Targets may be heard on VHF at long range but their position is unknown
[4] At long range it may not be possible to detect the aspect of another vessel visually
[5] Plotting needs to be carried out first before aspect can be determined
[6] Identifying colours visually will depend upon range
[7] Will depend upon size and, at night, if displaying lights
[8] Data such as course, speed, CPA and TCPA provided only after plotting
[9] Depends upon accuracy of data input by transmitting vessel
[10] Provided by the signal used

Do not conclude from Table 2.1 that one system is better than the other, as you also need to consider their limitations. For instance, understand that AIS is only effective when other ships are fitted with it and the information being transmitted is correct. Each lookout system's effectiveness will be limited by the OOW's own circumstances at the time, such as whether they are fatigued or facing equipment failure. Limitations shown in this table are explained in Table 2.2 on the next page.

Lookout limitations	Lookout type					
	Sight	Radar	AIS	Hearing	VHF	Echo-sounder*
Equipment failure		×	×		×	
Loss of power		×	×		×	
Mirages	×					
Background lights	×					
Target swap		×				
Number of targets		×		×	×	
Refraction (blind spots)	×	×				
Equipment provided on other ship			×		×	
Target material (ice, wood, glass-fibre)		×				
Target size and range[4]		×				
Radar and radio interference, optimum settings		×	×		×	
Very short range (under 2 miles)				×		
Target may be obscured in heavy rain/squalls[1, 2]		×				
Name, call sign, course, speed, type, status[9]	×	×		×	×	
Partial aspect/data only after target is plotted[5, 8]		×				
Colour (for aids to navigation)[6]		×	×	×	×	
Partial status only and at very short range[10]				×		
Can be more difficult at night[7]	×					
VHF may not always pick up signals at long range[3]					×	

Table 2.2 – Limitations of each lookout system

Notes

* In STCW but not a lookout system
[1] In very heavy rain, targets may be obscured on radar
[2] In very heavy rain, especially squalls, targets may be obscured on radar
[3] Targets may be heard on VHF at long range but their position is unknown
[4] At long range it may not be possible to detect the aspect of another vessel visually
[5] Plotting needs to be carried out first before aspect can be determined
[6] Identifying colours visually will depend upon range
[7] Will depend upon size and, at night, if displaying lights
[8] Data such as course, speed, CPA and TCPA provided only after plotting
[9] Depends upon accuracy of data input by transmitting vessel
[10] Provided by the signal used

Limitations to lookout capabilities

As shown in Table 2.1 there are limitations to all lookout methods set out in the Colregs and in STCW. Some of these lookout methods require an external power source, such as radar. Others employ a human sense such as sight or hearing, and these limitations are explained fully in *Human Performance and Limitations for Mariners* published by The Nautical Institute.

Although echosounders can show reduction in depth below the keel and any possible risk of stranding, they are not a lookout system. UKC is mentioned in STCW and Rule 6 but echosounders do not detect surface objects and are therefore no help in collision avoidance.

Visual – by sight

The importance of the visual lookout (sight) cannot be emphasised enough. It is, however, a human sense and has limitations. The first of these is fatigue – a fatigued lookout may miss some obvious targets. Small targets and those unlit at night may not be detected by visual means. Survivors in the water may not be seen, as the only visible part of their bodies showing in the sea may be their heads. Fishing nets are sometimes supported by tiny buoys and these may not be detected. Visual lookouts may experience mirages and it can be difficult for a watchkeeper to detect small navigation lights and navigation buoy lights, or to distinguish them from background lighting.

Binoculars can help with visual identification and enough sets should be available on the bridge for all those needing to keep a visual lookout. On a conventional ship there should be at least four pairs: one each for the Master, pilot, OOW and lookout.

IMPORTANT
There should be at least four pairs of binoculars on the bridge.

At night it will take time to adjust vision to the dark conditions, which is why very low intensity lighting is used on the bridge and cut-out switches are fitted on doors leading there. Visual lookout is affected by weather conditions and in fog can be close to zero.

A visual lookout is also dependent on line of sight, as we cannot see around corners or over the horizon. However, a visual lookout is the only way to detect colour, which enables positive identification of aids to navigation.

Radar

Radar is an aid to navigation that requires a source of power, so it could break down and needs frequent adjustment to detect targets in the clutter. Radar allows ships to 'see' in limited visibility conditions such as fog. Many ships are equipped with both 3cm (X band) and 10cm (S band) radars, allowing both fine discrimination and long-range detection of targets. However, radar is unable to detect many types of hazard, including small boats made from wood or glass-fibre that do not have AIS or VHF and offer a poor radar reflection.

Small contacts may be hidden from radar by small waves. Even larger ships may disappear in wave troughs generated by heavy ocean swells. Fishing nets also offer a low profile for radar and ice may be undetected.

Radar also suffers from two peculiar phenomena. One is known as target swap. This happens when two targets pass close to one another and the radar becomes confused and interchanges the data from one to another. The other is loss of target because so many ships (targets) are close to one another.

Aural – hearing

Hearing is a human sense and does not require a power source. It is severely limited in range and the bearing accuracy is poor. Different fog signals will provide the operational status of the ship sounding the signal, eg underway, underway but stopped and making no way through the water, NUC etc.

VHF – very high frequency

VTS stations often use VHF to provide traffic broadcast information and pilots use it for bridge-to-bridge communication. It gives no indication of the position of the other ship. Messages may not be understood due to the language used and unfamiliar accents and pronunciation. This can waste valuable time in anti-collision work.

AIS

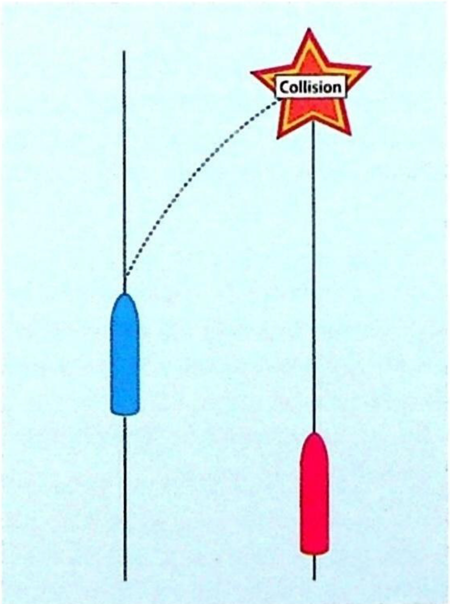
These systems are designed to provide information automatically about own ship to other ships, aircraft and to coastal authorities. This information includes own ship's identity, ship type, course, speed and navigation status (eg underway). The equipment also receives information of a similar type from other ships, monitors and tracks other ships and exchanges information with shore stations. The information received may be displayed on both ARPA and ECDIS. AIS is usually on at all times, but be aware that it may not be fitted on small craft and may be switched off on military vessels.

Situational awareness

Situational awareness means being aware of everything that is happening around you both outside and inside the confines of the ship. There are many conditions when situational awareness is essential:

- In traffic
- When navigating
- When steering
- When operating machinery
- In adverse weather
- Receiving and transmitting information
- The human situation
- In decision-making.

Traffic



The number and types of ships in the vicinity of own ship will influence our decision-making. The other ships may not pose an immediate threat but should we have to alter course, another ship close by could become a new collision threat. A typical example of this would be a ship on the beam or closely abaft the beam.

The presence of vessels such as fishing boats, dredgers or cable layers close to the route of own ship ahead may require own vessel to deviate from the planned track.

Plotting the movement of other ships to confirm they will pass own ship at a safe distance and maintaining a listening watch on VHF will help to enhance traffic situational awareness.

Navigation

This includes all the factors that contribute to monitoring the movement of own ship. The ability to fix the ship's position frequently by more than one method is paramount.

Take the horizontal dilution of precision – HDOP. This is the accuracy of the position provided by the global navigation satellite system (GNSS). The HDOP will be displayed by the GNSS receiver and the OOW will be alerted if it reaches an unacceptable level. Wherever possible, parallel indexing should be used as a continuous track monitoring system. If radar-conspicuous targets are available, they may be combined with parallel indexing to provide continuous position-fixing. When visibility permits, prominent lighthouses should be identified and their characteristics compared with those shown on the chart. Buoys and other floating marks should be confirmed in position. The position shown by the radar overlay should be compared with the position shown on ECDIS. Above all, it is essential to maintain the required margins of safety as documented in the SMS and the Master's Standing Orders.

Steering

In assessing situational awareness in steering you need to consider several questions. How many steering motors are in operation? Will it be necessary to turn another motor on or off soon? Is the ship steering well or should you turn on another motor to assist? If currently using automatic pilot for steering, does increased traffic mean you will need to switch to hand steering? If the ship is in track pilot, should you change to autopilot soon or engage hand steering?

Machinery

Here it is important to know what rpm the engine is making and the power output. If there's a need to slow down, could this be achieved quickly and safely? Is the engine room manned or operating in unmanned machinery space (UMS) mode? Will additional generators have to be started manually if the ship slows down or if it has a shaft generator?

Weather

You must be alert for indications that the weather is deteriorating, either through visual observation or through weather reports. You will need to assess if this change demands a different BWC such as using lookouts and radar operation. Check to see if the wind is increasing and whether waves are increasing the movement of the ship. If they are, then ask yourself if the ship and the cargo are sufficiently secured.

Keeping informed

Are you receiving all the reports you should? The GMDSS equipment should be functioning properly and the VHF should be tuned to the correct channel to receive traffic reports from VTS stations. The dual watch function should be operational.

The ship should be receiving marine safety information (MSI) and navigation telex (NAVTEX) reports, with the NAVTEX tuned to the correct station and set up to receive the correct messages. The AIS should be set up correctly and transmitting and receiving. Off-track alarms need to be set up correctly.

Is there information indicating that a change in course and speed may be required soon? Are there traffic reports about deep-draught ships or those engaged in special operations that could influence decision-making? Should you slow down or alter course?

Check to see if you are required to report to a VTS or any other shore station and what you need to tell them. Are you expected to report traffic information about own ship only or must you report any defects of own ship?

Human performance

Watchkeeping must be performed correctly, so it is vital to check whether any members of the bridge team are fatigued. You need to know if a lookout is required on the bridge or if the ship is operating sole lookout and whether the bridge navigational watch alarm system (BNWAS) is operating correctly.

Do you know where the crew are working? Are they moving, lifting heavy parts or using ladders? Are they out on the open decks? In any of these circumstances they could be in danger if the course needs to be altered and then the ship heels or starts to roll heavily, or if waves come on deck.

The effect of own ship on people nearby should be considered. Depending on the waters the ship is in, there may be long-distance swimmers, wind surfers, small sail boats or other recreational craft close to own ship's track. There may be people on the river bank and own ship could be generating a dangerous wash for them.

Decision-making

You may need to make several decisions in quick succession. If so, you'll need to assess the percentage of your time being occupied with decision-making. Ask yourself how many decisions are being taken at any time and whether that number is increasing. Then you can decide whether this seems to be manageable or if it would be wise to call for assistance. Examples of where decision-making is especially challenging is when own ship encounters a large fishing fleet or heavy traffic when approaching a restricted area for navigation.

Summary

Situational awareness requires you to take into account everything that is happening around you and within your own ship. It is important to keep your mental model constantly updated by means of a continuous lookout. Share information with the assigned lookout. Before problems manifest themselves, you should anticipate when conditions might become unusual and affect the vessel.

Situational awareness involves using all the senses, including smell and hearing, which could provide the first indication that something isn't right.

Distractions

If people are distracted from their duties serious consequences can result.

Case study: *Norwegian Dream*

In August 1999 passenger ship *Norwegian Dream* collided with container ship *Ever Decent* in their approaches to the Dover Strait. At a critical time just before the collision, *Norwegian Dream*'s OOW went to open the bridge door for an AB to bring the garbage book to be signed. This exchange took 3 minutes and the distraction effect on situational awareness contributed to the collision.

Most companies have procedures that aim to limit or contain avoidable interruptions. For example, use of mobile phones for personal communications on the bridge is generally prohibited. This rule is aimed at, first, preventing OOWs from losing situational awareness and, second, avoiding conversation that might distract the bridge team. The use of any company-provided mobile phone will be covered in the SMS and Master's Standing Orders. Pilots now use their phones to communicate with their base and OOWs should be diplomatic when ensuring that these calls do not distract the bridge team.

Smart phones can also be used as voice recorders, cameras or video cameras that are able to record key information. You must be aware of the company's orders concerning the use of mobile phones and smart phones covering these activities and you must follow them.

Playing music while on watch is another distraction and should not be allowed regardless of its source, eg mobile phone, tablet, computer or public address system. Music can block audible alarms that are designed to alert OOWs to problems, equipment failures or dangers.

Companies provide the necessary instrumentation for watchkeeping on the bridge, so personal laptops or computers should not be used. It is particularly important that no use is made of unapproved navigation programs. Official software for celestial navigation and route planning is not expensive and should be provided by the company.

Do not undertake any work that does not form part of your essential bridge watchkeeping duties. That includes preparing crew lists, crew declaration forms, safety equipment stencils, muster lists, and cargo or ballast plans. This type of work will distract you from the vital task of ensuring the safe navigation of the ship and it has no place on the bridge.

Major distractions are provided by non-navigation alarms (eg cargo-related alarms) that are located on the bridge. Control of cargo-related operations from the bridge, such as tank cleaning or starting and stopping pumps, is a major distraction for OOWs. An OOW should never allow themselves to become involved in prolonged testing of alarms sited on the bridge. Some of these alarms – including fire alarms and those covering general service pumps – can be monitored from the engine or cargo control rooms.

Other officers may occasionally visit the bridge whether on official business or not. As the case study of the *Norwegian Dream* shows, even official visits to the bridge can be a distraction – there is a right time and a proper protocol for these visits. Visitors should call in advance and ask when it is convenient to come to the bridge.

Prolonged VHF calls can be another distraction. You must, as OOW, choose the right time for initiating these calls. They are best done after the position has been plotted and after any anti-collision manoeuvre has been carried out. Sometimes these prolonged calls come from other ships and you are responsible for breaking the thread. Warships conducting anti-drug smuggling controls can initiate very long calls. A courteous reply such as "break – break I must suspend the call due to navigation duties" may resolve this. Masters may suggest ways of dealing with VHF calls in their Standing Orders.

IMPORTANT
Do not allow yourself to be distracted!

Monitoring the weather

There is no force of nature greater than the combined effects of wind and waves. They have destructive powers and should always be treated with respect. It is a tradition that navigators watch for signs of change in the weather and act on them to keep ships safe. Bad weather can delay ships, damage both cargoes and ships, create danger for ships' crews and produce uncomfortable conditions for passengers.

Ships can access high-quality weather reports from the World Meteorological Organization and private organisations contracted by the charterer, owner or manager of the ship. Reports may be received either from the GMDSS, NAVTEX or weather facsimile maps. Many ships are provided with private weather reports and information in digital format, which allows maps and data to be shown on a monitor overlaid with the ship's planned route. The changing weather can be viewed as a series of sequential maps combined with the changing estimated position of own ship. This enables the ship's staff to make early decisions to avoid extreme weather, prepare in advance for the onset of heavy weather and make good plans for ship maintenance.

Despite these advances, weather should still be monitored carefully. This is mainly a visual exercise, as the only measurements needed are for temperature and pressure, plus, if an anemometer is available, the wind speed. Close observation of local phenomena allows you to confirm the forecasted weather and detect any anomalies. The data recorded should include cloud coverage and type, wind speed, estimated wave heights, periods and direction together. These observations may provide the first signs of an approaching tropical revolving storm or the onset of fog. Ice or icing conditions will also need to be observed and reported. Masters are required by law to report ice and any winds above 50kt that have not been forecasted.

OOWs need to be aware of numerous weather conditions around the world, including trade winds, monsoons and areas affected by tropical revolving storms. In addition, there are local conditions such as the mistral in the Gulf of Lion, the Shamal in the Arabian Gulf and the Levanté in the Strait of Gibraltar.

Weather records in the deck logbook should show:

- Air temperature
- Sea temperature
- Surface pressure
- Wind direction
- Wind speed.

It is good practice to record additional information such as cloud coverage, cloud types, waves (both swell and wind) and their respective directions, heights and periods.

In addition to the use of thermometers and hydrometers, human senses can provide an advance warning of some of these conditions. For the Shamal your nose will detect the smell of dried mud from the Shatt Al Arab and you will note the sensation as the mucus membranes dry. When fog is approaching an increase in humidity can be felt on the face. Seabirds flying fast towards shore is a clear sign of an approaching storm.

The Mariner's Handbook, published by the UK Hydrographic Office, is carried on many ships. It contains photographs of various weather conditions and clouds, descriptions of tropical revolving storms and depressions, the trade winds and monsoons, and information about waves and their formation. All OOWs should study these images regularly to become experienced in recognising signs of important changes to the weather. Routeing charts for the oceans for every month of the year showing average weather conditions should also be consulted. The sailing directions also provide more local weather information for certain areas.

OOWs must notify the Master if they receive adverse weather reports or if they note a significant change in the weather. Heavy weather should be allowed for when preparing passage plans. You must be aware of your vessel's unique vulnerabilities and operating limitations in heavy weather. As the bridge watchkeeping officer you will be responsible for initiating heavy weather precautions as listed on the heavy weather checklist. They may include overall securing of the ship, measures to ensure the safety of crew on deck and prohibition of access to external decks.

Logbook weather records should be as accurate as possible, especially when noting wave heights – the tables in *The Mariner's Handbook* will assist in this task. Do not exaggerate conditions. Examples of how different ship types are manoeuvred in heavy weather to minimise damage in heavy weather can be found on YouTube.

Change of bridge watch

As soon as a ship lets go the last line, or the anchor is aweigh, navigation starts and continues until the ship is safely anchored or made fast alongside at the destination. The activity that controls navigation is bridge watchkeeping, and that must continue 24 hours a day, seven days a week. As one person cannot do this watchkeeping alone, the day is split into several watches, usually of 4 hours duration, so that each OOW has a watch (shift) pattern of 4 hours on watch and 8 hours off. A rating – usually an AB – will be assigned to each watch to act as lookout with a second as back-up. When required, the two will take turns at steering the ship by hand.

To maintain consistent safe navigation, it is essential that both the OOW and the AB pass on all relevant information to the next watch. The details for the change of watch are specified in STCW, which splits the handover into three phases: before, during and after.

Formerly, the watch handover was quite limited in scope, but now far more information is available to the OOW and should be included in the transfer. Many ships have systems to record what is being communicated at handover. It is normal to use a checklist for handover to ensure that no steps are omitted. The checklist may be hard copy or computerised. Here is an example of what should be on a checklist.

Before

On arrival on the bridge an OOW will usually check the Master's bridge order book which sets out their requirements for the day or night. The order book will usually be on the chart table if the ship still has a chart space, or beside the console where space is available for writing up logbooks. Once the order book is checked the OOW will acknowledge these instructions by signing them. The OOW will then check to see if there are any applicable work permits in force. If there are not, they should ensure they know where the deck and engine room crew will be working.

CHANGE OF WATCH CHECKLIST

From: 00-04 SECOND OFFICER

To: 04-08 CO

BEFORE HANDOVER

Before takeover, relieving officers shall satisfy themselves as to:

Bridge order book ☐ Daily orders ☐ Standing Orders ☐

Permits to work ☐ Crew working locations ☐

Latest MSI

Nav wngs read and signed ☐ NAVTEX read and signed ☐

Latest weather forecasts – read and signed ☐ Weather warnings – read and signed ☐

DANGERS checked forthcoming watch – UKC – CATZOC – Margins of safety XTL ☐

Passage plan info

Position (on track off track = XTD) COURSE T COURSE G COURSE M

True course ☐ Gyro course ☐ M. Compass Co ☐ Speed ☐ RPM ☐

Fit for duty

Check if AB is fit for duty – question ☐ Outgoing OOW asks oncoming OOW if fit for duty ☐

AT HANDOVER

Position (from known point) ____________ On/off track ____________

Passage plan # ###, present leg WP ## – WP 19; 36 miles to a/c ETA 2h 58m

Course ____________ Gyro/com error ____________ Set/l'way ____________

Speed (SMG) ____________ RPM ____________ ER status ____________

UMS ____________ AUKC ____________ MUKC ____________

CATZOC ____________ ECDIS ____________ Safety contour ____________

Safety depth ____________ CATZOC ____________ Safety domain ____________

Alarm status ____________

Nav eqpt status

Radar 3cm ____________PM Radar 10cm ____________PM Ranges ____________miles

GNSS ____________ (HDOP) ____________ GNSS alarm ____________

Traffic

quote AIS ID# ____________

quote range BRG ____________ quote CPA ____________

quote range BRG ____________ quote CPA ____________

quote range BRG ____________ quote CPA ____________

quote range BRG ____________ quote CPA ____________

quote range BRG ____________ quote CPA ____________

AFTER HANDOVER

Check position, course and speed ☐

Confirm equipment settings progressively ☐

Second check – ask AB if fit for duty ☐

NOTES

Change of watch documents on chart table

Change of watch documents on console table

Navigation warnings from Safety Net and NAVTEX will be consulted and printouts initialled to confirm they have been read.

Next, the OOW will review the latest weather reports from Safety Net, NAVTEX and, where provided on a PC, commercial weather forecast information. Once again, printouts must be initialled to show they have been read.

As incoming OOW you should now go outside the wheelhouse to make an all-round visual scan to observe the general weather situation by feeling the wind and smelling the air. Then go to the front of the bridge to confirm that your lookout has arrived. Check with them that they are fit for duty and not fatigued. At nighttime, this period will be used to allow the eyes to adjust to night vision, which can take up to 15 minutes. A quick visit to the bridge wings can be used to ensure that navigation lights are on and functioning correctly.

You should confirm the vessel is making the true course, the course being steered and the magnetic heading, and check whether either compass is displaying errors. You will then turn to the rpm and telegraph setting, the actual rpm, engine load, log speed and speed over the ground, before checking the UMS settings.

You should next consult the passage plan for details about the forthcoming watch. Where pilotage is expected this should include details agreed at the Master/pilot exchange (MPEX). It might cover matters such as dangers to navigation, navigation in a high-risk area, the safety depth and safety contour settings, the category zone of confidence (CATZOC), VHF channels to monitor, radio reporting points and waypoints.

The MPEX will also have details of mariner's alerts and warnings to be encountered. Most of these can be found on the ECDIS. It is also usual to confirm the UKC at this point. Then check the radar, ECDIS and AIS to familiarise yourself with traffic information.

At handover

Handing over the watch should not take place if an anti-collision manoeuvre is taking place. If you are handing over the watch, ask the incoming OOW if they are ready, fit to take over the watch and that they are not fatigued. The handover is now conducted orally, starting with the basics, some of which the incoming OOW will have investigated in preparation for their watch:

- BWC
- Ship's position
- Course true and that being steered
- Compass errors, both gyro and magnetic
- The rpm and speed of the ship, both log and over the ground
- The ship's draught, anticipated squat and UKC
- The ECDIS safety settings
  - Safety contour
  - Safety depth
  - Safety domain
- The traffic in own ship's vicinity
  - Quote those showing AIS/ARPA ID numbers
  - Note that different ID numbers may be used on different radar sets
- Navigation equipment status
  - Gyro error
  - Compass error
  - Performance monitor
  - HDOP
- GMDSS equipment and status
- Visibility, actual and forecast
- Prevailing and predicted tides and currents
- Waypoints
- Radio reporting points
- Dangers to be encountered in the next watch
- Work permits in force
- Crew work plans and work location.

If both OOWs stand close to the bridge voyage data recorder (VDR) microphones, this exchange will be recorded. Items can be marked off on the checklist as they are completed. The record will be retained by the VDR. An audible exchange should now take place so that all members of the bridge team can hear; two examples are given below.

Second officer – *Change of bridge watch – second officer takes over from third officer*
All the bridge team – *Second officer has the watch.*

ABs on lookout duty should have a similar exchange, restricted to what they can see.

Lookout – *12-4 AB takes over lookout duty.*
All the bridge team – *12-4 AB takes over lookout duty.*

This process of verbal exchange is known as closed-loop reporting. On passenger ships the sheer number of people in the bridge team means that it may be necessary to limit this type of reporting to prevent it becoming a distraction. A relevant entry can be made in the logbook according to company instructions.

After handover

The OOW has a second exchange with the lookout enquiring if they are fit for duty. The OOW now goes through a process to check all shown on the handover. These checks should be shown on the checklist (see page 34). Safety rounds are usually conducted by the OOW who is signing off and who reports to the bridge when these are complete.

Avoiding collisions

Collisions are the worst type of maritime accident. The collision between ro-ro passenger ferry *Doña Paz* and the tanker *Vector* resulted in the loss of 4,386 lives, the worst maritime loss of life on record during peacetime.

As well as loss of human life, a collision can cause damage to the environment, damage to the ship, loss of cargo and damage to the ship operator's reputation. Even a small collision can be very expensive. It is therefore the overriding duty and obligation of OOWs to avoid colliding with another ship or fixed object. When you sign your contract of employment there may be a clause saying that you confirm that you will follow the owner's and Master's instructions and these will specifically include obeying the Colregs.

REMEMBER
It takes two to make a collision but only one to avoid it.

You will know about the Colregs because you were questioned about them at your OOW CoC examination. The Colregs are quite detailed and contain information and instructions about how collisions should be avoided. The steering and sailing rules explain which ships shall give way to others and what the stand-on vessel shall do, including what to do when the other ship is not taking any action.

You may experience many types of encounter during a voyage, each requiring the application of different Colregs. It isn't possible to suggest every possible variation, but the examples that follow show some of the most common scenarios. Remember that the Colregs are divided into these sections:

- Part A General
- Part B Steering and sailing rules

- Part C Lights and shapes
- Part D Sound and light signals
- Part E Exemptions
- Part F Verification of compliance
- Annex I Positioning and technical details of lights and shapes
- Annex II Additional signals for fishing vessels fishing in close proximity
- Annex III Technical details of sound signal appliances
- Annex IV Distress signals.

Determining risk

For this section refer to Rule 7.

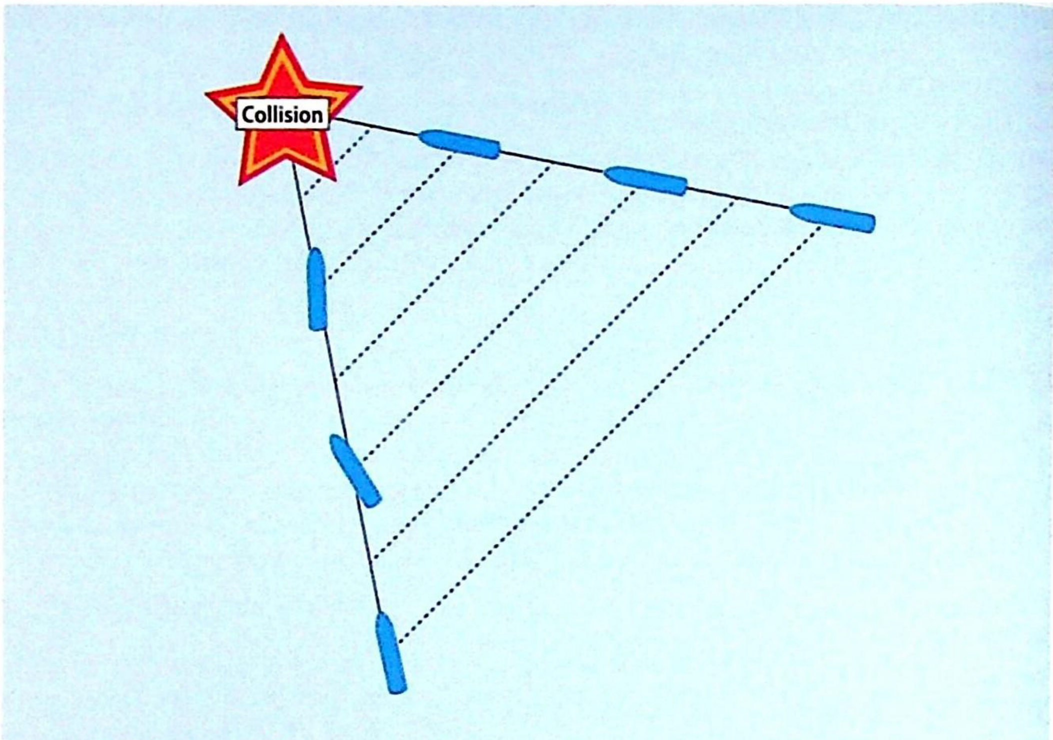
To be able to avoid collision you must first identify those vessels or other fixed and floating objects that pose a risk of impact. It is therefore necessary to carry out continuous surface surveillance. In the Colregs this surface surveillance is known as lookout – see also Rule 5.

The various means of lookout are:

- Visual
- Aural
- Radar
- AIS
- Radio.

Visual

If a target is sighted visually, a series of compass bearings should be taken and if these do not change, then there is a risk of collision. Alternatively (and additionally) the target may be acquired either manually or automatically on ARPA and the plot observed. As you will see from this diagram the blue ship yaws off course but the compass bearing does not change, indicating that the risk of collision still exists.



The collision triangle shows why the true bearing of the other ship must be used rather than the relative bearing caused by, for example, the ship yawing

If you receive the first warning of an approaching ship from the ARPA or AIS, the theory is the same: you must check the bearing either visually or by radar and if the compass bearing does not change then there is a risk of collision – Rule 7 (d) (i).

Aural

If another vessel is detected by sound ONLY, for instance in poor visibility, then it will be necessary to confirm its presence – usually by radar and/or AIS. If it cannot be confirmed, then Rule 19 (e) applies.

Radar

Radar detects the presence of vessels and displays the target on the radar screen. The ARPA can be used to automatically plot the target and provide information about the target's course, speed, CPA and TCPA.

Some radars have an association function: the target acquired on radar and the AIS active target each have their own vectors although coming from the same target. If the association function is ON and course, speed, bearing and distance are within limits (variable and set up by the OOW), then radar and AIS vector will become a single vector. This provides additional assurance that target data – primary course and speed – are accurate. Consequently, CPA, TCPA and bow crossing range (BCR) are more precisely calculated.

In congested waters it is good practice to activate the AIS filter. Depending on the ship's equipment, there will be a ring filter (by distance) and a sector filter (by bearing). These filters ensure the screen is not overloaded with AIS target symbols and the AIS high-capacity alarm. However, the filter should be used with caution so as not to exclude possible important targets. It should be frequently checked and re-set as necessary. As soon as conditions permit, the filter should be removed.

IMPORTANT
Always use the radar data for collision avoidance purposes and use the AIS filter with caution so you don't exclude possible targets.

It is also good practice to cancel all acquired targets from time to time – on both radar and AIS – and re-acquire relevant targets in the vicinity. Timing is very important: do not do this when targets that pose a collision risk are close to own vessel. Advantages to doing this are that it:

- Removes irrelevant and out-of-sight targets
- Removes false targets
- Removes lost-target alarms, reducing alarm fatigue
- Refreshes situational awareness
- Concentrates attention on new targets in the vicinity.

AIS

AIS will show the presence of another vessel fitted with AIS together with its position, course and speed and, most importantly, its name and call sign. This can be displayed on the ARPA and ECDIS. If the target data on the ARPA and the AIS coincide you can be reasonably certain they are the same ship.

Radio

A VHF broadcast (Securité) may be received, alerting vessels to the presence of another vessel that may be unable to show lights or cannot comply with Colregs in some other way. A similar message may alert traffic to vessels engaged in special operations such as cable-laying. The approximate position of the vessel will need to be plotted on the radar and the echo of a target used to confirm its presence.

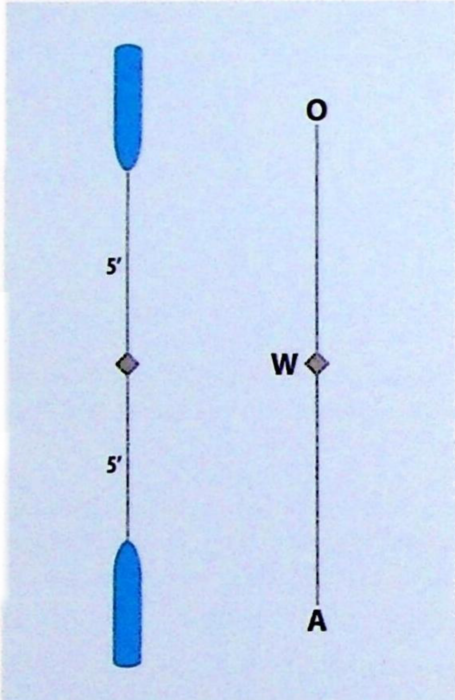
IMPORTANT
Where the risk of collision exists, it will be necessary to apply the Colregs and take action to avoid collision. Use the data from ARPA (CPA, time to CPA etc) for collision avoidance purposes.

Main types of collision risk

Ships posing a risk of collision may follow any course and speed and the examples given are the simplest. The five main types of collision risk are:

- Approaching end-on from ahead
- Crossing from starboard
- Crossing from port
- Overtaking or being overtaken
- Complex

Approaching end-on from ahead

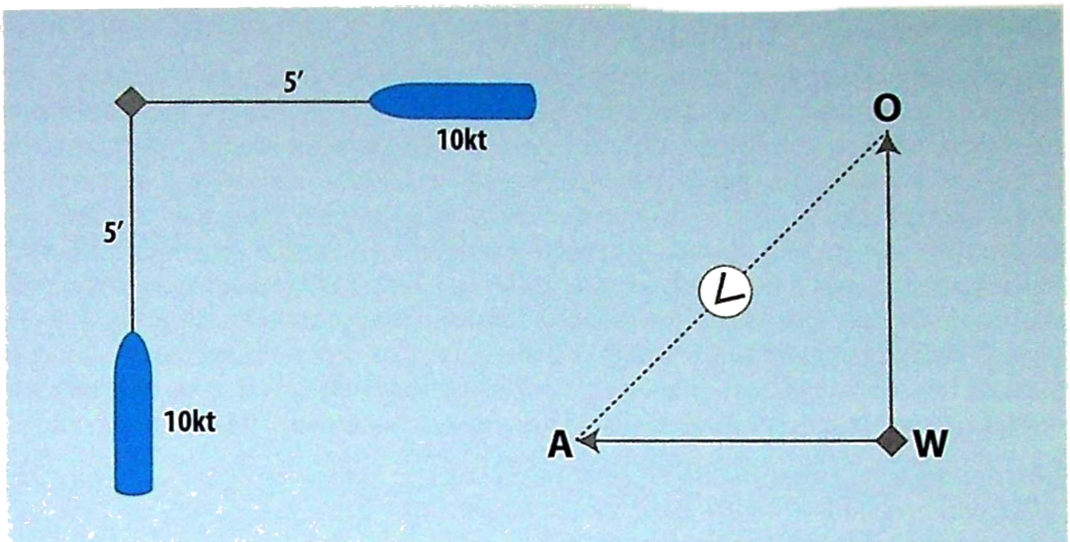


Two ships approaching end-on

This type of collision can happen very quickly. The approach speed of any two vessels on a collision course is the combined speed of both. If two ships travel at 15kt the approach speed will be 30kt so the ships are closing at 1 mile every 2 minutes. This situation does not give much time to ascertain risk and then manoeuvre to avoid collision. As illustrated in the diagram showing an end-on approach from ahead, if no action is taken the ships will collide in 30 minutes. According to Rule 14, both ships should alter course to starboard.

Crossing from starboard

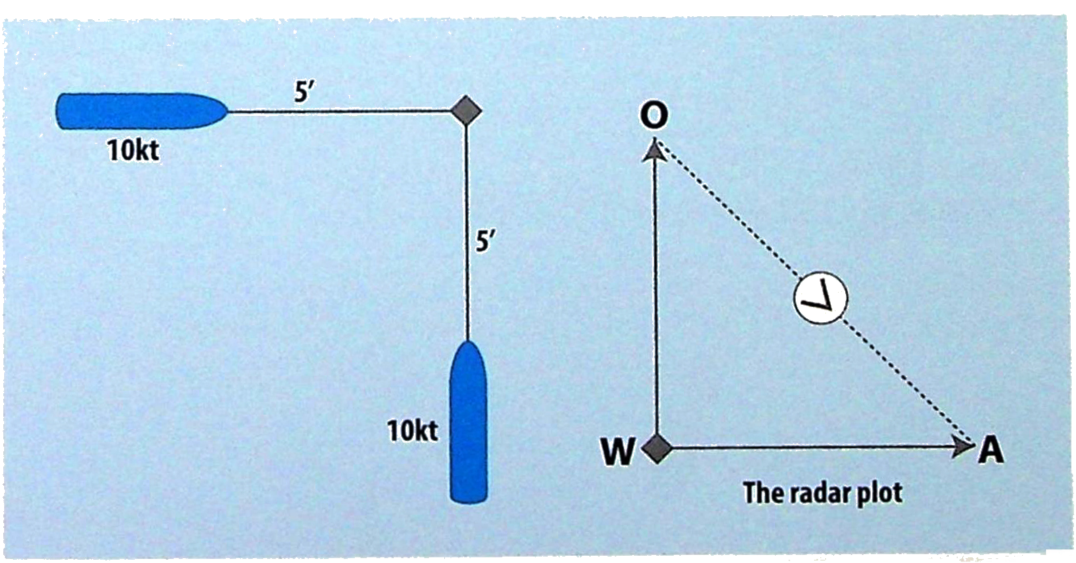
This collision threat does not develop as quickly as a head-on situation and is simple to resolve as own ship is the give-way vessel. From the next diagram we see that if no action is taken the ships will collide in 30 minutes. According to Rule 15, own ship should alter course to starboard.



Crossing from starboard

Crossing from port

This situation, as with crossing from starboard, does not develop as quickly as others, but is complex to resolve as you will not know if, and when, the other ship will alter course for you. This is very likely to be the case with small craft that are able to stop in a very short distance and do not understand the concern they cause. In the diagram illustrating this, if no action is taken the ships will collide in 30 minutes. According to Rule 15, ship B should alter course to starboard to pass astern of own ship.



Crossing from port

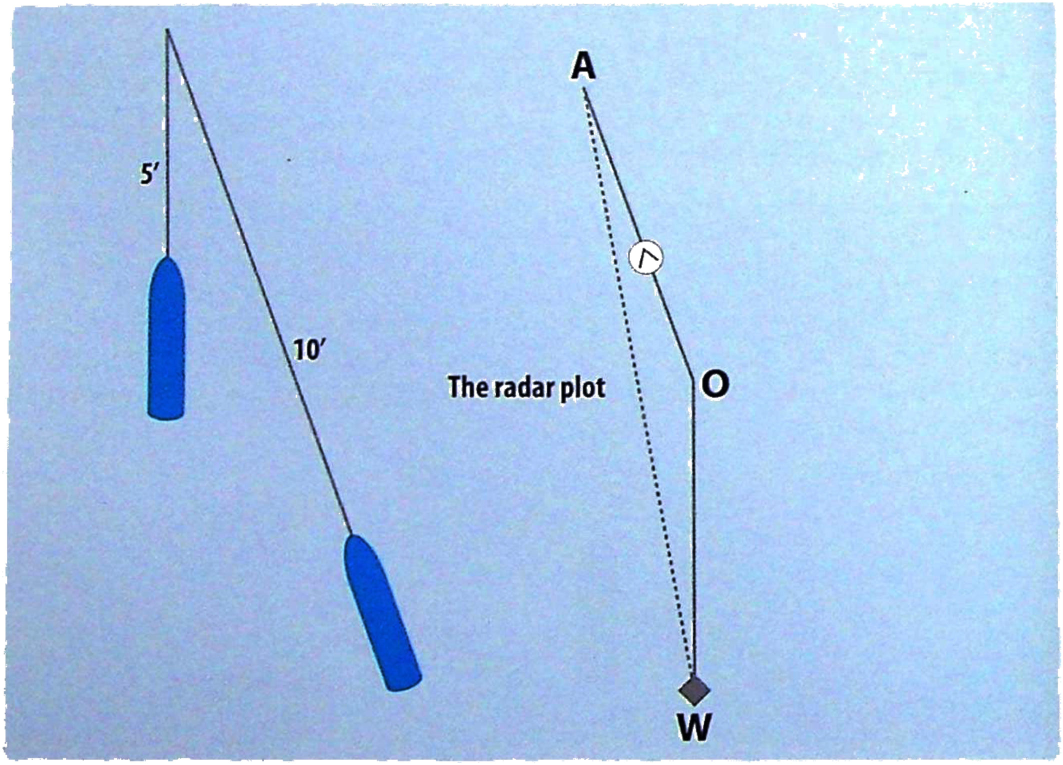
Overtaking

This type of collision takes longer to develop than the preceding ones, especially if the difference in speed between the two vessels is very small. If you are the ship being overtaken, then you should maintain course and speed and the other ship should keep out of the way. If you are the ship overtaking, the question is which way will you alter course? In the example in the diagram illustrating overtaking you could alter either way. Altering to port gives the quickest solution to avoid a close-quarters situation. However, if crossing traffic from starboard is expected, you may prefer to alter course to starboard to keep the starboard side clear for collision manoeuvres. Note that when taking this option you must be well clear of the overtaken ship before altering back to port to recover your intended track. As the overtaking diagram shows, if neither ship takes any action, then the ships will collide in 30 minutes. According to Rule 13, ship C should keep out of the way.

Each case must be judged on its individual merits. Ships provided with ARPA have a function called trial manoeuvre which provides the OOW with decision support; for example, informing you of what will happen if you alter course 30° to starboard within 6 minutes.

IMPORTANT

If overtaking, get well clear of the overtaken ship before altering course back to recover your intended track.



Overtaking

Complex collisions

These include ship encounters involving the risk of collision with more than one ship and more than one type of collision which may develop quickly or slowly.

Actions to avoid collision

There are two main actions to take to avoid collision: altering course and altering speed. At all times follow the Colregs, especially Rule 8. I would like to sound a note of caution though. As a new OOW, you will quickly become familiar with the use of ARPA. This will provide you with CPA and TCPA information measured in decimals of a mile. You may be tempted to use these small margins to determine your action to avoid collision. DON'T DO THIS! It is not good seamanship. What starts as 0.315 miles when there is the risk of collision can soon become 0.125 miles. Work on the CPAs specified in the Master's Standing Orders. See Rule 8 Part a.

IMPORTANT
Any action to avoid collision must be taken in accordance with the Colregs, especially Rule 8.

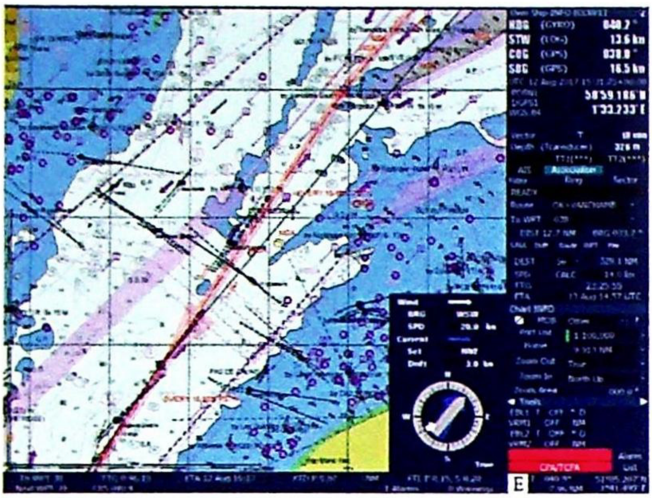
Altering course

If there is enough sea room and, provided it does not result in a close-quarters situation with another vessel, altering course alone is the usual method of avoiding collision – see Rule 8c. To alter course there must be a flow of water past the rudder; in other words, the ship needs to be moving through the water.

Altering speed

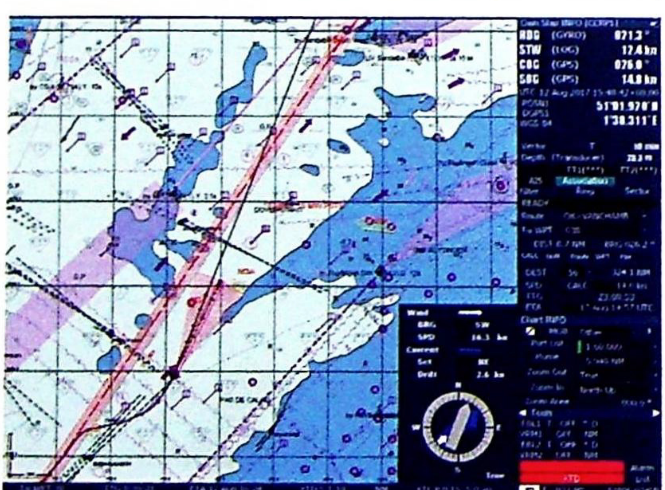
If there is not enough sea room to avoid collision by altering course, then slowing down (or even stopping or going astern) may be the only option – see Rule 8e. Large, heavy ships will take a long time to slow down due to their inertia, so reduction of speed alone may not be effective for collision avoidance. Speed reduction on those ships needs to be planned in advance.

You cannot break the main engine by slowing down, for example, by going from full ahead to dead slow ahead. Automated systems on modern ships will take care of all the alarms the engine department needs. Your priority is to avoid the collision.



Vessel crossing from starboard – risk of collision

Own vessel alters course to starboard to avoid collision



Crossing vessel past and clear, own vessel alters bacl to track

In some parts of the world, escort ships are provided

Close overtaking

It is important to ensure that any action taken is effective. That means you must continue to monitor the other ship posing the risk until it has passed own ship and is clear. It is also important to ensure that any action taken does not lead you into danger of another kind. Additional risks to be aware of include colliding with another ship, running aground, contravening traffic separation regulations or hitting aids to navigation.

REMEMBER
Not all ships observe the Colregs!

Vessel not complying with Colregs (just above the starboard crane)

Avoiding grounding

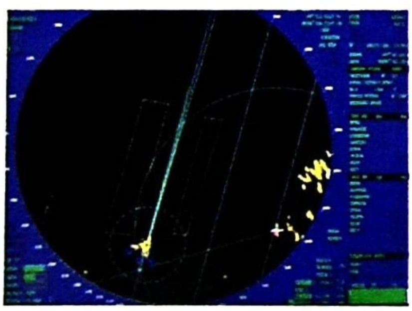
To avoid running aground you need to know where the safe water is – where the water is deep enough to allow the ship to stay afloat. You will need to know what the change in the height of the tide will be, as the ship must pass over shoals at the right time. Sand waves may also affect the depth. This information comes from a variety of sources: the chart or ENC, tide tables and sailing directions.

REMEMBER
Prudent navigators never rely on a single source of information; they check, monitor, control and record.

The Master will appoint one of the OOWs as navigator with the task of preparing a passage plan. The whole purpose of this plan is to identify a safe track in advance and highlight areas of danger so that adequate precautions can be taken. The OOW's role will be to execute and monitor the plan to ensure that the ship maintains its intended track.

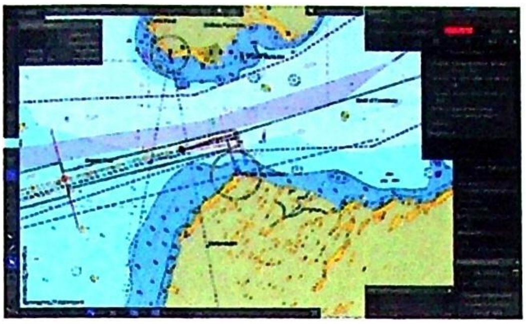
> *Analysis of marine accidents shows that despite modern precision navigation and anti-collision systems, the art of navigation is less about knowing where you are than knowing where you should be.*
>
> 'Landfall and the Coast', by the late Captain Paul Whyte MBE FNI,
> *Seaways*, December 2016

To monitor the passage plan and track of the vessel the OOW will have to monitor the ship's position by fixing (see the section on position-fixing, page 54). As most ships are now fitted with ECDIS, monitoring will be performed automatically at set intervals using the input from GPS. It will show these positions on the ENC. Many ECDIS have a facility to show the radar picture on top of the ENC (overlay) and this allows the echoes of the coastline and other conspicuous objects to be superimposed on the charted outline of these features. Yet another immediate check that the ship is following the intended track is to use parallel index lines (on ARPA) on a conspicuous feature.



A radar map with parallel index lines and a bearing and distance from a conspicuous target – in this case a lighthouse

Bearings and distances can also be plotted to confirm the ship's position. Visual bearings and radar ranges may be combined for fixing the ship. However, trying to plot a three-lines-of-position (LOP) bearing or range fix on ECDIS is very time-consuming and is of little benefit if other systems are functioning.



Left – ECDIS display of the GPS position, radar overlay (darker yellow shading), parallel index detail for transfer to radar/ARPA and upcoming PVF; right – Screenshot of the PVF

What we do need is an independent means of occasionally comparing the GNSS fix with the relative position from a known conspicuous object, in other words, to calibrate the GNSS fix. This comparison gives us a position sensor integrity verification fix or PVF. This is best performed when conspicuous objects are visible on the beam or two conspicuous objects are in transit, such as leading lights. Combined with a range, these can provide a very accurate position.

X-REF
See section on position-fixing on page 54.

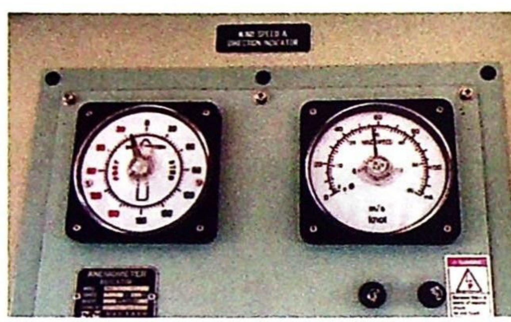
Beam bearing of lighthouse for PVF

Course

To make sure the ship maintains the right track, it is necessary to ensure the correct course is being steered. First determine the compass error – usually at least once each watch and after any major alteration of course. Next it is necessary to ensure the helmsman is steering the correct course by frequently checking the ship's heading. If the ship is in automatic pilot, there will be an off-course alarm to alert the OOW if the ship is not maintaining the correct heading. Some ships are also provided with a magnetic off-course alarm which provides a second independent method of advising when the ship is off course. On ships fitted with a second gyro compass there is yet another system which compares the heading from both gyro compasses and again sounds an alarm if the difference exceeds a set value.

The ship's course over the ground will be the heading as affected by leeway. In the following image a screenshot shows the ship is making 12.5° leeway due to a strong wind.

Vessel making 12.5° leeway



The same ship with the anemometer showing 60kt wind

UKC

Routes need to be planned in safe water to ensure ships are in sufficient depth and the actual depth under the keel at any time needs to be monitored. This requires the use of the echosounder, which will measure the depth under the keel so the clearance can be assessed. This can be displayed as UKC or depth of water allowing for the draught of the ship. If the latter system is chosen it is essential that the echosounder is programmed with the correct draught.

Most echosounders have an alarm to advise the bridge team when a value (the safety depth limit) has been reached. Several alerts can be set. The first is for when the ship reaches shallow water – a UKC equivalent to the draught of the ship. This can be reset to the safety depth as shown on the passage plan. A further limit may be set when the ship is to operate at minimum underkeel clearance (MUKC).

Some ECDIS and radars have depth alarms that can be set independently from the alarm on the echosounder. If these are available, care is needed to ensure these alarms are synchronised across equipment.

UKC calculations form part of the passage plan. The passage plan will also indicate which parts of the voyage are critical for UKC and those areas where the quality of the survey is not so good. These are shown by CATZOC on the ENCs and indicate areas where special caution may be required.

The echosounder showing the actual UKC

Squat

UKC can be affected by squat, because the relative movement of water past the hull of a ship reduces clearance. Most ships have the effects of squat displayed on the bridge in either tabular or graphic form – see examples on next page. These show the reduction in UKC caused by speed. When compiling the passage plan, the navigator will calculate squat and indicate the locations where this is critical.

Heel

Draught will increase if the ship heels either when turning or from the effect of rolling. Most ships have a table posted on the bridge to show increases in draught due to heel. If the ship has a low GM it can heel significantly when turning and the places where this could occur should be shown on the plan. Heel can be significant when ships make large turns around breakwaters when entering ports.

Onshore set and areas of strong currents

An example of strong set and drift

These should be shown on the passage plan. Be prepared in advance to apply allowances to the true course to counteract all onshore set and areas of strong currents.

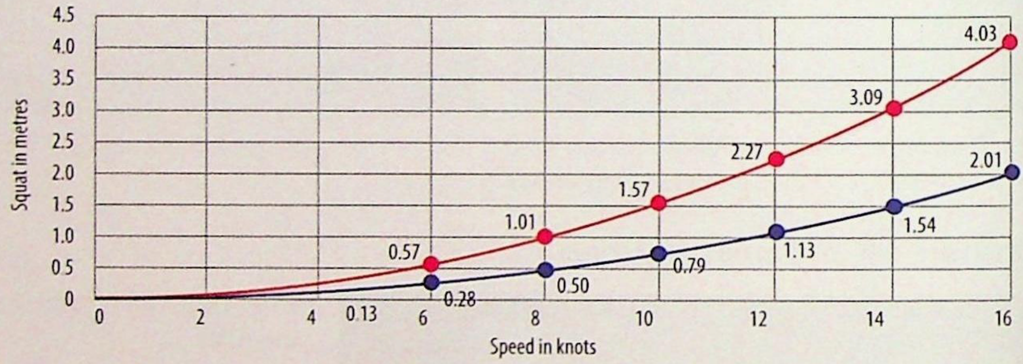
In the example of strong set and drift, the ship's heading is 316° but the course over the ground is 305° – a difference of 11°. The vectors show the actual set of the ship is about 200° shown from the point of the arrow on the 316° vector to the point of the arrow on the 305° vector.

SQUAT CALCULATION DISPLAY

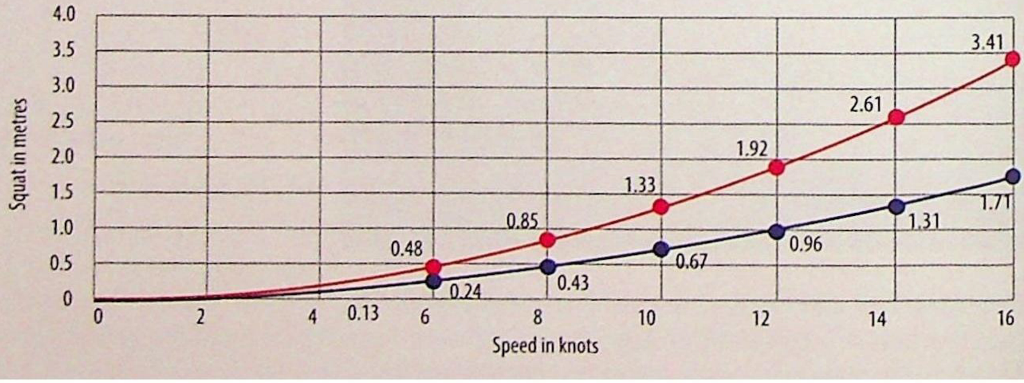
Squat Loaded		Speed	Squat Ballast	
Confined	Open	knots	Confined	Open
0.00	0.00	0	0.00	0.00
0.06	0.03	2	0.05	0.03
0.25	0.13	4	0.21	0.11
0.57	0.28	6	0.48	0.24
1.01	0.50	8	0.85	0.43
1.57	0.79	10	1.33	0.67
2.27	1.13	12	1.92	0.96
3.09	1.54	14	2.61	1.31
4.03	2.01	16	3.41	1.71

Calculated C_b (loaded) = 0.7870 **Calculated C_b (ballast) = 0.6667**

SQUAT LOADED



SQUAT BALLAST



INCREASE IN DRAUGHT DUE TO HEEL OR ROLL

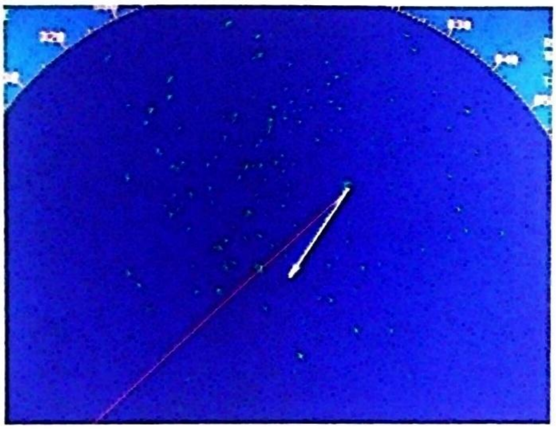
FORMULA: ID(M) = 0.5 × B(M) × SIN A

Explanations to formula abbreviations
ID = increase of draught XXX to heel (in metres)
B = ship's beam (in metres)
A = angle of heel (in degrees)
sin = sine (angle of heel)

List (degrees) port/starboard side (angle A)	Factor 0.5	Ship's breadth	Sin A	ID metres
1	0.5	45.00	0.01745	0.393
2	0.5	45.00	0.03480	0.783
3	0.5	45.00	0.05430	1.177
4	0.5	45.00	0.06970	1.568
5	0.5	45.00	0.08715	1.961
6	0.5	45.00	0.10452	2.352
7	0.5	45.00	0.12186	2.742
8	0.5	45.00	0.13917	3.131
9	0.5	45.00	0.15643	3.520
10	0.5	45.00	0.17364	3.907
11	0.5	45.00	0.19080	4.293
12	0.5	45.00	0.20791	4.678
13	0.5	45.00	0.22495	5.061
14	0.5	45.00	0.24192	5.443
15	0.5	45.00	0.25881	5.823
16	0.5	45.00	0.27563	6.202
17	0.5	45.00	0.29237	6.578
18	0.5	45.00	0.30901	6.953
19	0.5	45.00	0.32656	7.325
20	0.5	45.00	0.34020	7.655

This shows the increase in draught due to heel. For a large vessel of 60m beam, the increase in draught due to a 30° roll is 15m!

Leeway



As with strong currents, allowance must be made for leeway.

A ship makes 20° leeway in the Bay of Biscay

Position-fixing

Fixing the ship's position is one of the prime duties of the OOW. How the position is fixed will depend on the ship's location and the equipment and instruments that are provided on board. Before we discuss different position-fixing methods it is important to understand the difference between the various position systems.

Latitude and longitude

These create a grid around the Earth which can be plotted on a chart. By quoting the latitude and longitude coordinates we can refer to the position of anything, such as a ship or conspicuous object. This position reference is obtained from GNSS and other electronic position-fixing systems. Latitude and longitude may also be obtained by calculating celestial navigation fixes.

Bearing and distance

We may quote a position as a bearing and distance from a known object, for example a visual bearing and a radar distance. When we plot either position, they ought to show the ship in the same position on the chart. If not, either the position information, such as the GNSS input, is wrong or the charted position of the known object is incorrect. When using paper charts, the OOW may have made a mistake. Most charts were originally compiled using the bearing and distance method, so when a sounding or other feature was located, the position was obtained using a bearing and distance from a known and conspicuous object. This feature had a latitude and longitude on paper charts.

Many ENCs were created by using the same latitude and longitude as the original paper chart survey. Many of these positions were quite accurate, but errors are more likely if the surveys are older and farther offshore. Errors in positions of charted features therefore still exist on ENCs – see *The Mariner's Handbook* for details. This is why it is vital to check source quality on all charts and zones of confidence for ENCs and why navigators should check their position frequently by alternative means.

IMPORTANT
ENCs created from paper charts may contain errors from past surveys. Never rely on a single position-fixing system. Check your position frequently by other means.

Position-fixing methods

The position-fixing methods available to the mariner are: GNSS, radar, visual and celestial. The ship's location and the equipment it is fitted with will determine which system is employed. The areas where a ship could be located can be defined as: deepsea, coastal or rivers and estuaries.

In deepsea passage the ship will be out of sight of land, more than 50 miles distant, and is in water more than 200 metres deep. It would take the ship more than an hour to encounter the nearest danger. It is less likely that the ship will encounter other vessels. This is a simple definition, because if traffic increases more ships are likely to be encountered, even if you are far from land.

Deepsea navigation position-fixing can be carried out by celestial navigation or GNSS. Celestial navigation is usually over three fixes a day, and more if planets are available. Fixes are usually carried out in the morning and evening for the stellar (star) positions and at noon using the sun. GNSS provides the position continuously.

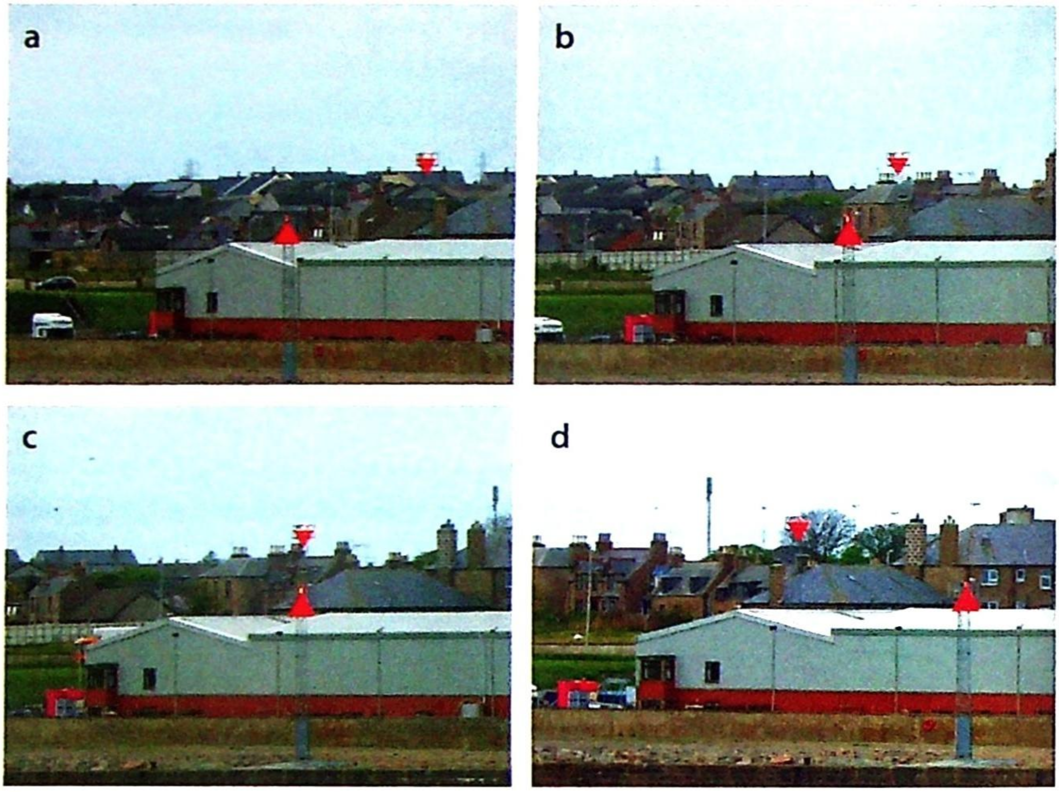
In coastal waters ships will be within sight of land and usually in water depths of less than 200 metres. It would take the ship 15–20 minutes to encounter the nearest danger. Occasional underwater dangers may be encountered, and there is an increased likelihood of meeting other ships, fishing vessels and vessels engaged in underwater exploration. There may be traffic separation schemes that the ship is required to follow. Most traffic follows routes parallel to the coastline.

For coastal navigation it is possible to obtain position fixes using GNSS including DGNSS, radar ranges and bearings, parallel index lines combined with a radar range, visual bearings, visual bearings and radar ranges.

In rivers and estuaries the ship is obliged to follow channels where there is sufficient depth of water to navigate. These are usually indicated by buoys and beacons, which may be floating or fixed navigation marks. The ship will need to alter course frequently and will constantly be navigating close to underwater dangers.

For river and estuary navigation it is possible to obtain position fixes from GNSS, usually DGPS, radar – primarily parallel indexing or radar range and visual bearings, especially leading lines or leading lights. Sector lights will also show OOWs which side of the centreline they are on.

Leading marks



These photographs show a ship being set down by the current at a harbour entrance.
(a) the ship is to the north of the leading line
(b) the ship is being set to the south (and almost on the leading line)
(c) the ship is on the leading line
(d) the ship is now south of the leading line

Traditional navigation using paper charts involved plotting positions on the paper chart from all sources using pencil, parallel rulers or roller ruler/navigation triangles. Officers became proficient at performing this task. Fixes, once plotted, were always historical and there was nothing but the course line ahead of the ship on the paper chart.

The introduction of ECDIS has, however, introduced continuous position-fixing and intervals can be selected to show historical position fixes; for instance, for every 5 or 10 minutes. If it is desirable to demonstrate fixing by an alternative means on the ENC, a new approach must be considered. This is due to the complexity of plotting a visual fix using three bearings, which is made additionally difficult because of the own ship symbol. Many keyboard strokes are required, and by the time the position has been plotted the ship has moved on. This makes it difficult to compare both the visual fixes with the GNSS reading. Plotting a visual fix in this way is impractical for routine use, although it can be used to recover the ship's position when there has been a prolonged outage of the GNSS position.

As stated before, a prudent navigator never relies on a single source of information and GNSS is a single source. A secondary system is needed in the event of failure of the GNSS sensor input. For preference, this system should operate alongside the ECDIS. A tried and tested method is combining parallel indexing with a radar range, which allows the position to be monitored continuously. Both provide very accurate position lines that may be used to verify the position provided by GNSS.

The parallel index line can be shown on both radar and ECDIS and the variable range marker (VRM) on both sets can be adjusted. Any difference in position will be identified immediately. The event mark can be used to record when the verification of the GNSS position on the ENC took place.

On ships fitted with the radar overlay on ECDIS it is possible to show whether the radar echoes coincide with the charted features.

REMEMBER
Never rely on a single source of information for position-fixing.

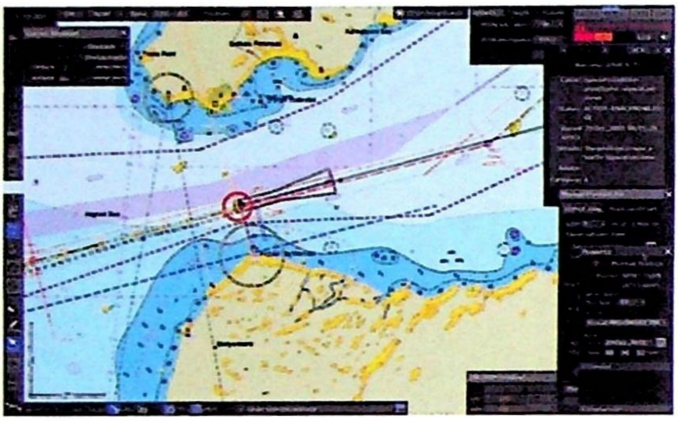
ENC without radar overlay

ENC with radar overlay

On these two screenshots you will note the parallel index lines already marked to be used on the ARPA. GNSS fixes are recorded as small black dots behind own ship. The priority of position-fixing systems to be used should therefore be:

- GNSS
- Parallel indexing/radar range
- Radar overlay (where fitted)
- Radar range and bearing
- Visual bearing beam or heading mark/leading light together with radar range.

In the following screenshot from ECDIS, various methods of positioning are shown. The historical GNSS positions are shown with a time stamp behind own ship. The parallel index line is shown on the lighthouse – the actual display is on the radar. Radar ranges are taken off the same light approaching. Radar overlay is shown as a darker orange colouring on the coastline/higher ground – note they are coincident. The clearing line is shown to allow a PVF to be taken when the lighthouse is abeam. This compares the GNSS position with an accurate visual/radar fix at exactly the same time.



Simultaneous position-fixing systems

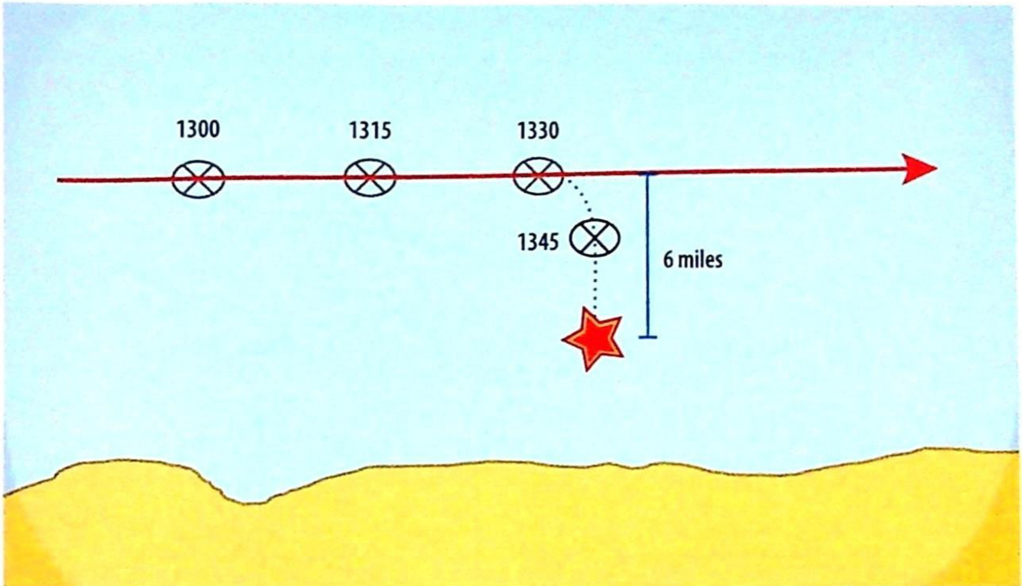
Position fixing interval

The purpose of fixing the ship's position at regular intervals is very simple. It is to determine the course and speed made good to enable the set and drift to be measured. An appropriate allowance can then be made to the course being steered to ensure that the intended track can be followed more closely.

When navigating with paper charts, time intervals were usually chosen to enable simple mental arithmetic calculations to determine speed, ie by using decimals or fractions of an hour such as 5 minutes ($\frac{1}{12}$), 6 minutes ($\frac{1}{10}$), 10 minutes ($\frac{1}{6}$), 12 minutes ($\frac{1}{5}$) and so on. Speed calculations would be based on three fixes to average out any errors made when plotting a single fix.

More importantly, the interval was to ensure the ship never ran into danger between fixes, and so the time was established to ensure a new fix was plotted well before the ship could hit an obstruction. A simple rule was established whereby the position-fix interval was equal to half the time it would take to reach the nearest obstruction.

The next diagram shows a ship sailing on an approximate course of 085° at a speed of 12kt. It is passing off a danger at a distance of 6 miles, taking 30 minutes to reach it, so half that time would be 15 minutes. The position-fixing system is $\frac{3}{12} \times 60 = 15$ minutes.



Position-fixing interval

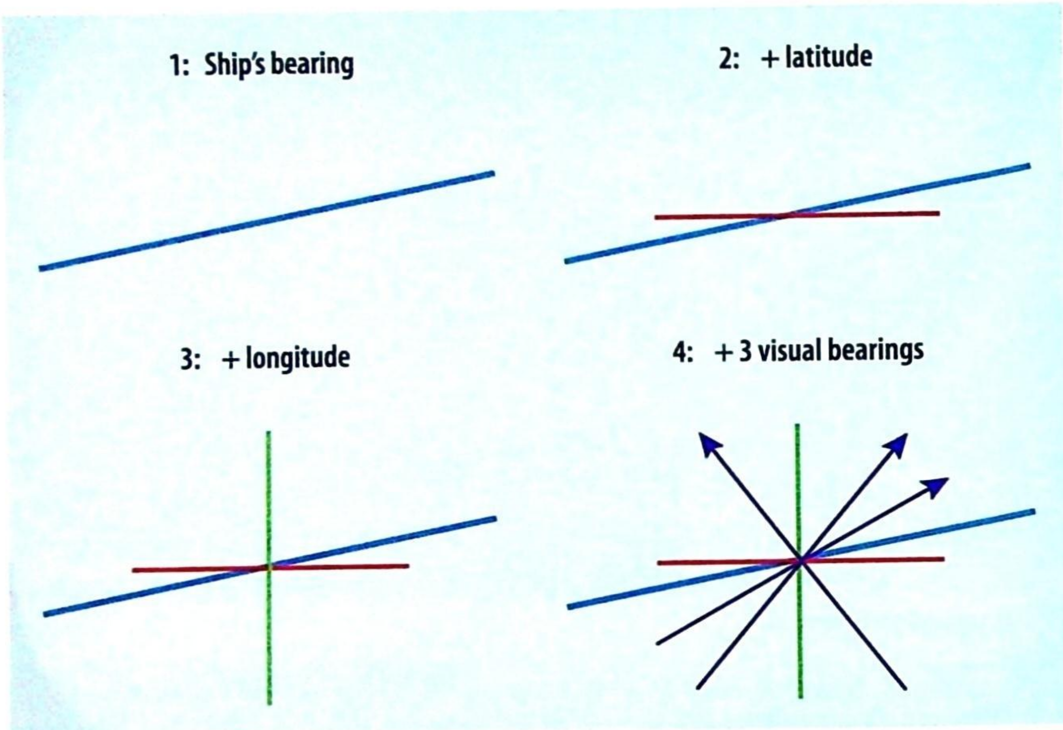
If the gyro had failed just after 13.30 but was not detected, the position-fixing interval would still allow a fix to be plotted (at 13.45) before the ship reached danger and for corrective action to be taken. This actually happened on a ship with no magnetic off-course alarm. It went aground.

It is very difficult to plot the ship's position on paper charts at intervals of less than 5 minutes, and so parallel indexing is used. A parallel index line can be used to ensure a ship remains on track, but it is not a position fix. When combined with a radar range of a conspicuous object, however, it can offer a very accurate fix.

Many ships today have systems to alert them if they are off-course or off-track. An automatic pilot off-course alarm will sound if the ship is not following the course as set. A magnetic off-course alarm will warn the OOW if the difference between the magnetic course and the true course exceeds a set value. Other alarms include the XTE (cross track error) from the GNSS when the displacement of the vessel from the intended track exceeds a certain value. Some ships are fitted with a second gyro compass and an alarm will sound if the difference between the two gyro compasses exceeds a certain value.

GNSS allows the possibility of almost continuous position-fixing, but it will still be necessary to check the accuracy of the GNSS positions. This is best done simultaneously using GNSS and another position-fixing system. These are called position sensor integrity verification fixes or PVF.

Various position lines can be plotted on a paper chart to fix position: first latitude, then longitude, and third three visual bearings. By the time the fix is plotted it is already history. On an ECDIS, it is not very easy to plot a three-bearing fix at the same time as a GNSS fix.



Plotting latitude, longitude and three bearings

The size of the own ship symbol makes it difficult to plot a three-position line fix simultaneously on the ENC. For the cross to be visible, the ship (and hence symbol) must move ahead. By this time the position is history and instant comparison is lost

Alternative measures must therefore be adopted. Very accurate bearings can be used for a very accurate fix. These could include a beam bearing or leading lights combined with a range of the light or conspicuous object, if they are in line. These bearings can be set up in advance on the electronic bearing line (EBL) and variable range marker (VRM) of both the ARPA and ECDIS. Once on the beam, use the event mark button on the ECDIS to record the event.

X-REF
Screenshots and photographs on page 49 demonstrate this.

So, wherever possible the fixing intervals should be:

System	Frequency
GNSS	Continuous
Radar (parallel indexing with radar range)	Continuous

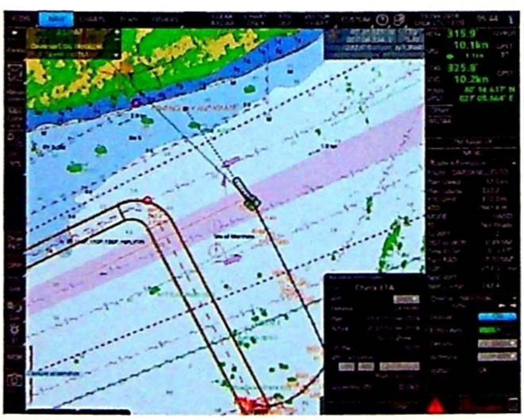
Fixing intervals

In this there are two systems independent of one another offering continuous comparison.

Where parallel indexing is not possible, then the systems in the table below may be used to compare the positions provided by the GNSS.

System	Frequency
Radar (radar overlay)	Use occasionally only
Radar (ranges/bearings)	Use periodically depending on proximity of danger
Radar/visual – when visibility allows	Use periodically (a visual bearing with a radar range)
Visual (heading marks/leading lights)	Use continuously where available and visible on port approaches

Comparing positions provided by the GNSS



Examples of fixes by various means

A position sensor verification fix

In the left-hand image above, the GNSS position is shown as black dots behind own ship. Various other positions, shown in orange, are plotted to confirm the ship's position as it gets underway from an anchorage. The radar overlay appears as the green shading on the coastline.

The right-hand image above shows the GNSS positions, parallel indexing and PVF off Çankaya Point. Note that parallel indexing is conducted on the ARPA. The distance off and bearing of the index line are taken from the ECDIS and transferred to ARPA.

Position sensor failure

If the GNSS position sensor input to ECDIS fails, switch to the second GNSS sensor. If both fail, then the ECDIS will continue to plot the ship's dead reckoning position (DR). This will give an acceptable position for a considerable time, but once shore lights become visible or the land can be seen on the radar, you should obtain either a visual or radar fix and plot this on the ECDIS. This is when the three-bearing fix comes into use and the LOP function is used. Officers should be using two position-fixing systems simultaneously where possible, so that should one system fail they can continue with the other system. Many companies follow best practice and carry out ECDIS and GNSS failure exercises to confirm that the bridge team can perform this function.

For further details on position-fixing, readers are advised to refer to *The Admiralty Manual of Navigation Volume 1: The Principles of Navigation*. Details of error sources for GNSS can be found in *ECDIS and Positioning*, by Dr Andy Norris FNI. Both books are published by The Nautical Institute.

Speed

The speed of a ship is directly proportional to the revolutions of the ship's propeller. The normal operational range of rpm of the main engine falls under two headings:

- Manoeuvring rpm, used when entering or leaving port, which necessitate frequent changes in speed and/or direction (ahead and astern)
- Sea speed, which may be any speed from full ahead manoeuvring to maximum rpm.

A typical telegraph and main engine control panel

The ship will usually be on manoeuvring rpm until the pilot disembarks when the speed will be increased to a maximum. At the change from full ahead manoeuvring to full speed, the telegraph is moved beyond full ahead to full sea speed; this time is known as full away on sea passage (FAOP).

The Colregs require all ships to proceed at a safe speed at all times. Remember that ships underway will squat depending on draught and UKC. So safe speed is applicable for avoiding both collisions and grounding. But what exactly is a safe speed?

Colregs Rule 6 defines safe speed as a speed at which a vessel can take "proper and effective action" to avoid collision. This speed should ensure the vessel can stop within a distance "appropriate to the prevailing circumstances and conditions". Those circumstances and conditions include:

- Reduced visibility – there will be less time to take action
- Traffic density and proximity of ships – more ships, more collision risks
- Background light – affects the ability to detect other ships under way or at anchor.

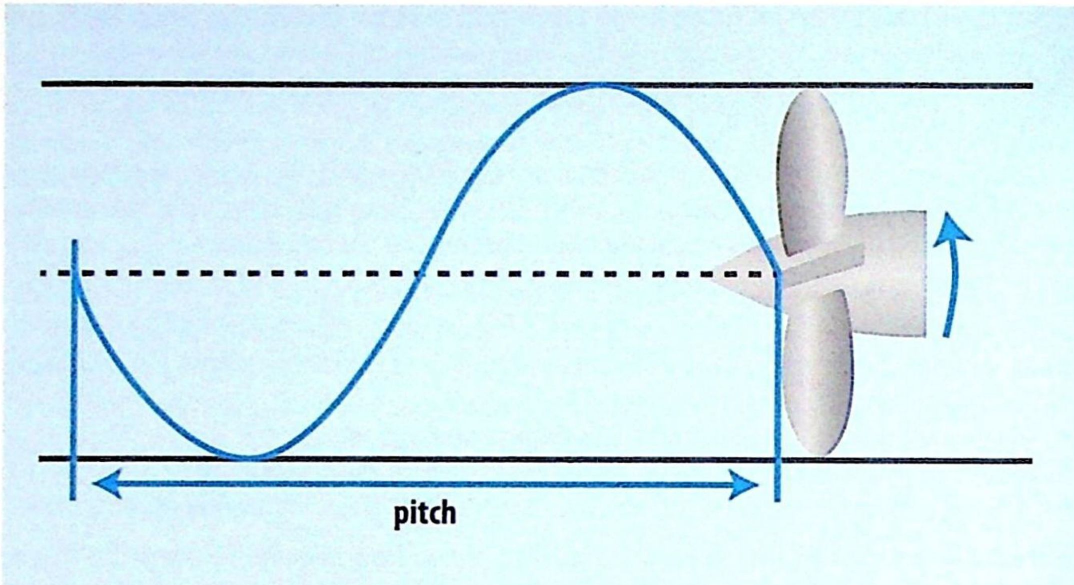
In the past, safe speed was considered to be a speed slow enough to allow the ship to come to a stop in half the visible distance. By this definition, in fog this was almost zero. After radar came into general use, safe speed referred to the use of the engines for collision avoidance. In that case, speed reduction would need to be achieved in an appropriate time depending on prevailing circumstances. Therefore, if the audible detection range of a fog signal was 2 miles and the other ship was also identified on radar, the safe speed should allow own ship to be brought to a stop in 1 mile.

The rules now cover ships with operational radar. If the target is detected on radar and plotted, safe anti-collision manoeuvres can be undertaken at a slow speed to allow the ship to be stopped for safety reasons before a collision could occur.

We shall now look at speed in general.

Speed through the water

A ship's speed through the water depends on the number of revolutions and the pitch of the propeller. Theoretically, for one revolution the ship will move ahead a distance equal to the pitch.



Relationship between pitch and distance. The curve represents the trace made by the propeller during one revolution. The distance the propeller moves in a forward direction during this one revolution is called the pitch

The theoretical speed of the ship is then:

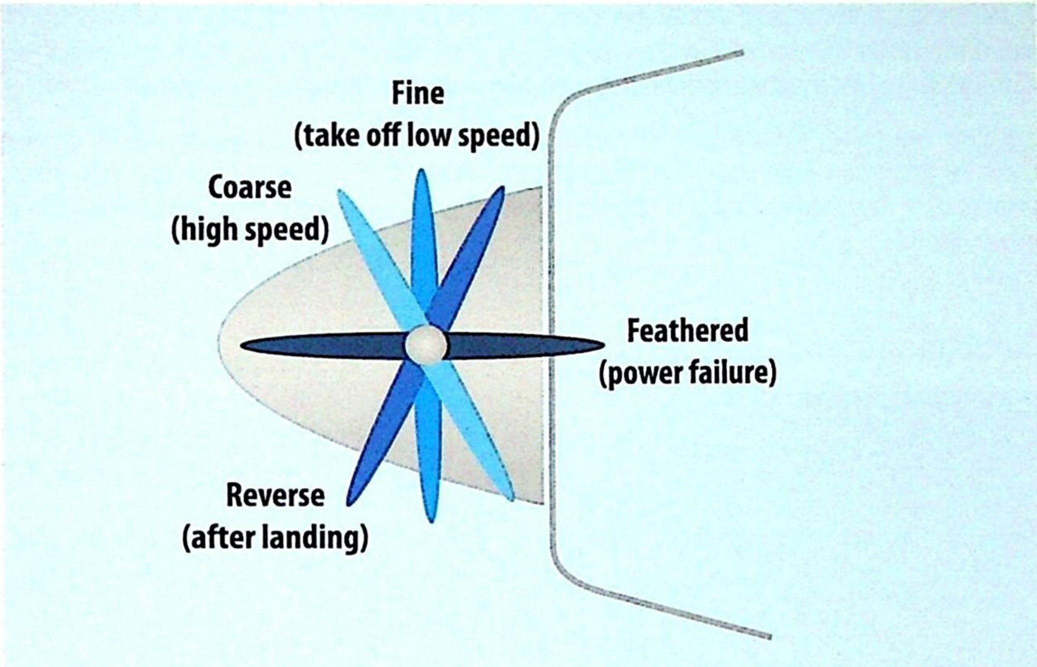
$$\text{Speed (knots)} = \frac{\text{pitch (metres)} \times \text{rpm} \times 60}{1850}$$

As there is no such thing as a perfect machine, the actual speed will be slightly less. The propeller will be affected by slip and this will reduce the speed of the ship. Slip is the difference between the theoretical and actual distance moved by the propeller. Many factors contribute to slip and it is usual to allow about 5% slip for a new ship or one just out of drydock. Slip can also be affected by the movement of the ship in bad weather and the trim of the ship.

Most ships have a small table showing the theoretical speed of the ship at the telegraph settings of dead slow, slow, half and full ahead. The same table will also show the critical rpm of the main engine. In the past it was common to find an rpm/speed table showing the speed of the ship against all rpm, sometimes in steps of 5rpm. It would be good to re-establish this practice.

Variable-pitch propellers

Some ships are fitted with variable-pitch propellers, either with the engine running at a constant or a variable speed. Tables will be provided to show the speed against various angles of pitch.



Propeller pitch. This example is from an aircraft, but the same theory applies on ships. The blade rotates to adjust the pitch

Speed through the water will also be affected by the wind and, depending on the direction, will be either favourable or adverse. The maximum effect on speed will be when wind is from right ahead or right astern, and minimum when it is on the beam.

Speed over the ground

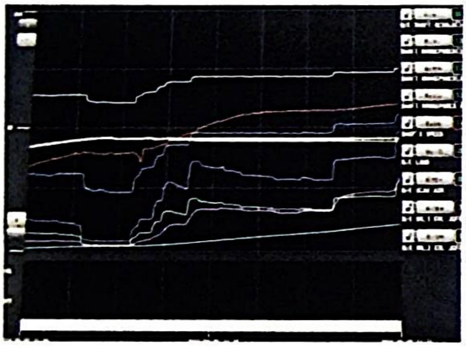
This is the speed over the Earth's surface, which is affected by currents, known as set and drift. Most ships' engines in use today are reciprocating diesel engines, although some still have turbine engines. Most ships are also classified as UMS, so it is not necessary to have an engineer in the control room to change speed. However, there may be ships that have ancillary equipment, such as a shaft generator, that will require the presence of an engineer if speed is changed significantly.

The main issue to consider when changing the speed of the engine is thermal stress. If you took a drinking glass cold from the refrigerator and filled it with boiling water, it would crack. Consider a ship's diesel engine running for days on end and then suddenly it was stopped and put into reverse. To stop the engine would require injecting compressed air into the engine cylinders. Compressed air is needed to restart the engine to go into reverse. The relatively cold compressed air will have a similar effect on the engine to the boiling water on an ice-cold glass – it can cause cracking in some sections of the engine.

A ship with a turbine engine requires two turbines, one for ahead and one for astern. If the ahead turbine is stopped while it is very hot, the rotor will bend, which is catastrophic damage. This problem does not affect ships fitted with variable-pitch propellers.

It is therefore good practice for both types of engine to reduce speed gradually to ensure these temperature differences are maintained within safe limits to prevent engine or turbine damage. Speed should be built up gradually when a ship clears port and slowed down gradually when arriving. This will reduce thermal stresses on engines if major speed changes, such as stopping or reversing, are required.

Economical speed



Most ships sail at economical speeds to minimise both fuel consumption and harmful emissions. Power is generated below the maximum continuous rating (MCR) and there will be less heat in the main engine. This allows engines to be slowed down almost immediately. Most ships entering service today have computer-controlled engines to economise on fuel at all times.

Fuel economy display

Safe speed

Safe speed is defined in the Colregs as a speed at which the OOW can slow down immediately when taking action to avoid a collision. It is impossible to forecast exactly where a collision may place. It is possible, however, to forecast where there might be an increased probability of ship encounters and where the room for manoeuvre to alter course may be limited.

Any definition of safe speed must take into account the environment in which the ship is operating. This includes river transits, where the ship's wake could cause bank erosion and where barges, small craft and unattended vessels may lay alongside close to each other.

The lookout function includes monitoring the ship's wake and it is possible to predict in advance where it may be necessary to reduce speed. The position of any potential slowdown must be included in the passage plan.

In the same way, while the ship is underway, it may be possible to observe a situation developing where a speed reduction may be required and ensure that speed is reduced in advance.

IMPORTANT
Commercial pressure must never influence safe speed.

The manoeuvring diagram will contain information about stopping distances and turning circles in various conditions. As a watchkeeping officer, it is your responsibility to be familiar with these. The diagram must be displayed on the bridge.

Margins of safety

In this section, the term 'margin' means a limit or boundary. The margin of safety therefore means a limit or a boundary of safety; if we stay within this boundary the ship will be safe. Once the boundary has been crossed, the risk increases and may quickly become uncontrollable.

Passing under Tower Bridge in London with margins of safety above, below and at each side

Vertical margins of safety

UKC

This is the vertical distance between the bottom of the keel and the seabed. The operating company will usually establish limits for UKC depending on conditions such as water depth or whether water is open or closed. UKC will be calculated for each section of the voyage and shown on the passage plan. This should be compared with the actual depth under the keel as shown by the echosounder. The SMS will usually contain a UKC calculation form; once completed, the form should be attached to the passage plan. It is essential that reliability of chart data is taken into account.

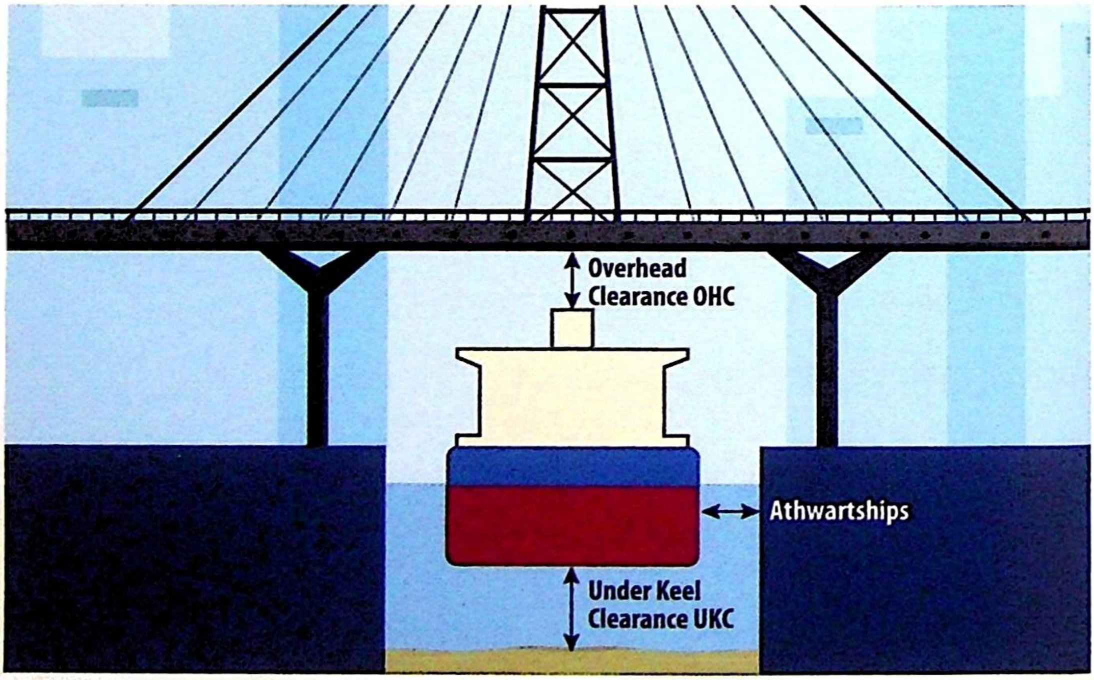
Commercial pressure should not influence an inadequate UKC. All depths must be carefully considered and, when necessary, speed reduced to lessen the effect of squat on UKC. Real-time data will become more widely available in the future.

Overhead clearance

This is the vertical distance from the highest point of the ship to the lowest point of an obstacle the ship must pass underneath (usually a bridge). It is calculated in advance.

Left, the vessel is about to pass underneath a bridge

Right, the manoeuvre is shown on the ECDIS



Margins of safety: horizontal margins of safety

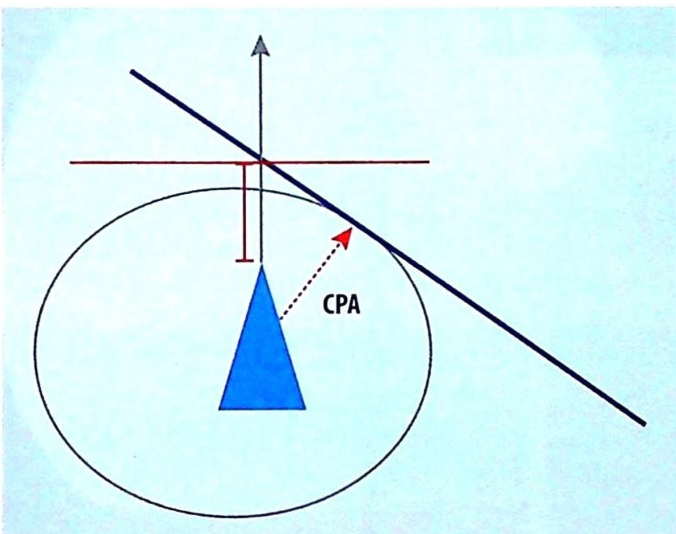
Bow crossing range

The horizontal distance from the stem of the ship to a point directly ahead. This is used for establishing a safety limit in collision avoidance.

Athwartships

The horizontal distance from the beam of the ship to a point abeam of the ship on either side. Usually used in navigation to specify a distance off land or a parallel index range.

Tangential

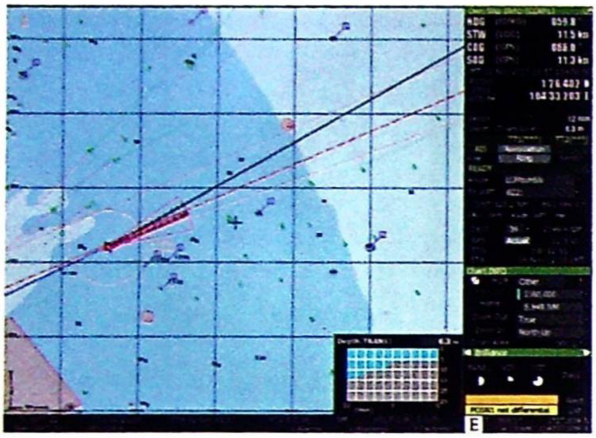


A horizontal distance to a tangent line, usually used in collision avoidance and known as CPA.

Horizontal margins of safety used in collision avoidance

Special margins of safety

On an ECDIS it is possible to create a special margin of safety and, depending on the manufacturer, this may be termed cross track distance (XTD) or cross track limit (XTL). A specified value can be set for each course the ship plans to follow. At the planning stage, during the check route function, the entire track between these limits can be scanned to identify dangers before putting the plan into action. If the ship stays within the XTL it will be safe. If it goes outside these limits for a short time, then the safety frame (an anti-grounding cone) will alert the OOW to any dangers when entering the frame. Note that this has been referred to at least once as 'cross track corridor' (XTC); however, this is not an official term. A better term would have been 'check route corridor'.

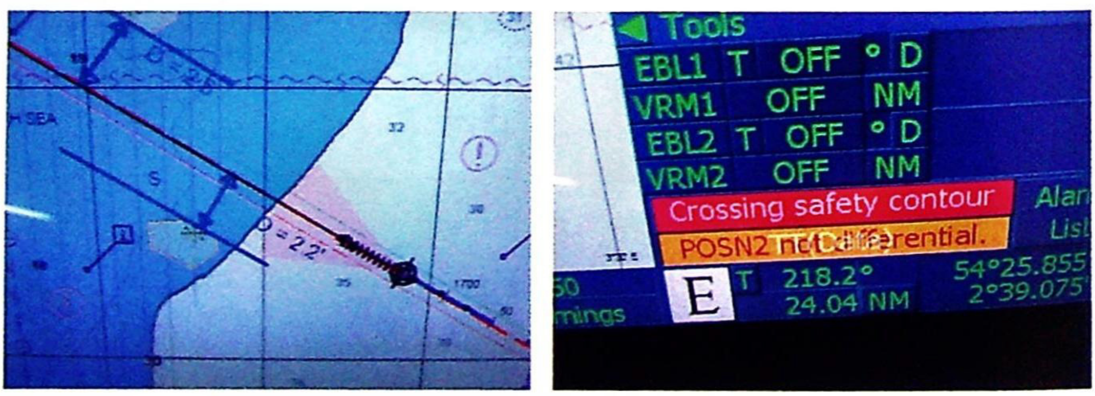


In this screenshot from an ECDIS, own ship is left below centre. On the port side of the ship the XTL is shown in red and set at 0.9 miles. On the starboard side the XTL is shown in green and set at 0.7 miles. See bottom menu bar: the ship is 0.06 miles off-track to starboard (XTD)

The XTL is set at 0.9 port and 0.7 starboard (bottom menu bar)

Additional margins of safety

ECDIS offers more margins of safety by providing the OOW with alarms when approaching danger. For example, an alarm will sound if a ship's safety frame touches the relevant contour. More safety contours can be set by the user, including mariner's alert lines and warning lines or areas.



The anti-grounding cone touches a depth contour (testing the alarm)

Avoiding errors

Two main faults are common in bridge watchkeeping – human error and equipment error.

Human error

People can and do make mistakes. We are not machines and cannot start and stop at the push of a button. Nor are we good at performing repetitive tasks for long periods. To be able to concentrate for a long time, we need to take breaks. We can also become tired, suffer from fatigue and the dulling effects of boredom.

Bridge watchkeeping is a safety-critical activity and mistakes can have serious consequences. Mistakes must be detected before they develop into disasters. Most of the time seafarers do detect their own mistakes and correct them in advance of problems. When they do not, events can spiral out of control and the results can be disastrous.

Three types of human error must be avoided – those based on poor skills, those from not adhering to rules and those due to lack of knowledge.

Skill-based errors may occur if we work without thinking. If an activity is performed many times it can be undertaken almost automatically – but an important step may be forgotten or one operation mistaken for another.

Rule-based errors arise when established rules have either not been applied at all or have been applied incorrectly; for instance, when the Colregs say we should give way and we do not.

Knowledge-based errors can happen when decisions are made based on the interpretation of unfolding events. If that interpretation is incorrect, an incorrect decision will follow. Decisions might be based on the assumption that another ship will maintain its course and speed but it doesn't. Do not make assumptions. Guard against complacency.

High stress levels, fatigue and the length of time spent on board can all lead to reduced attention, concentration and response times. A poor safety culture, insufficient training, inadequate communication and experience, combined with decisions made with insufficient knowledge, can lead to errors. To be effective, any message must be understood by the receiver, who needs to make sense of the same set of circumstances as those giving orders.

Intentionally or unintentionally, companies may create organisational influences that have a poor effect on performance. Inadequate time may be allocated for tasks – for instance there may be insufficient time to perform all the required pre-sailing checks. Poor design may hinder some operations, especially if a person needs to perform several tasks simultaneously, such as when operating the ship's telegraph and monitoring the ship's position.

If too few people are available to complete the workload at a particular time, then no individual will be able to complete all tasks safely. When the safety culture is inadequate, the company may not hear about these problems – inadequate time allocated for tasks, poor design, insufficient personnel or a combination of these factors. A good safety culture requires these circumstances to be reported immediately so that the company can take action.

Equipment error

Equipment error will occur when:

- There is total or partial failure
- There is failure of equipment, safety systems and alarms
- Uncalibrated or incorrectly set-up instruments give inaccurate information
- Targets are undetected on radar due to incorrect settings
- Land and navigation marks are not detected from ECDIS
- Obsolete information is shown on charts and in publications.

How to avoid errors

Plan all activities in advance and identify hazard control points – times and places where there is a critical activity or margins of safety are reduced. Anticipate errors that could be made and have strategies to control them.

Use the checklists provided to ensure you do not omit steps in a procedure and cross-check instruments frequently to ensure they are providing reliable information.

IMPORTANT
When alarms sound, check why – do not rush to cancel them.

Anticipate. Use the 'what if?' question in advance to help your decision making. If that ship ahead of me alters course to port might it collide with me?

Think out loud. Share what is on your mind with the lookout. By taking them into your confidence they will repay you by warning you if they see something they feel is not right.

REMEMBER
If a situation develops that you do not know how to resolve, call the Master – they want you to do this.

If the workload between monitoring the passage plan and collision avoidance becomes too much, increase the BWC according to the SMS. If you are not sure about anything, ask. There is no such thing as a stupid question.

To avoid appearing as if you are seeking conflict when questioning senior officers' intentions, you can use the phrase:

"Verification of intention, pilot (or Captain): will you slow down for this ship ahead?"

Always use more than one system to confirm information such as position-fixing, target detection, course and speed. As soon as you see anything going outside accepted limits, make it known. For instance, if the ship is off course or exceeds safety margins and the off-course (OCA) and XTL alarms sound. Phrase your questions and instructions carefully to avoid misunderstandings.

Several issues of The Nautical Institute's free magazine *The Navigator* cover these topics. Copies can be downloaded from www.nautinst.org. Issue 13 deals with the crucial area of error management and minimising mistakes.

Avoiding misunderstandings

Misunderstandings arising from ineffective and inefficient communications have led to many errors and accidents. If you are effective, you will be doing the right thing. If you are efficient, you will be doing the right thing properly. Communications on the bridge are mostly either written or oral. The bridge watchkeeper gives and receives instructions using both forms of communication.

REMEMBER
If you are effective, you will be doing the right thing. If you are efficient, you will be doing the right thing properly.

Most written communications will be received by watchkeepers, including company procedures, circulars, letters and memorandums. Written communications sent by watchkeepers might include noon reports, notes to the other watchkeepers and onboard instructions to the crew or the engine department. Some of these written communications will need to be checked by the Master or CO before being sent. Keeping appropriate records can help to avoid misunderstandings.

Oral communications can be both internal and external. Internal communications may be face-to-face, perhaps between Masters and officers, and between officers and crew members. Internal communications may also be remote via telephone to any point on the ship. External oral communications are usually made via VHF, satellite or mobile phone.

The key to being understood when communicating orally is to ensure the recipient is familiar with the terms being used. There are various ways of ensuring this. The first is to use the message markers as described in the standard marine communications phrases (SMCP).

Here's one such exchange:

Ship – *Question: which side will the pilot board?*

Pilot station – *Answer: port side please, ladder one metre above the water*

Another way to avoid misunderstandings is to use phrases described in the SMCP or, if a standard message has to be sent, use the template in the radio signals publication. You can also use the International Code of Signals and prefix your message with the word INTERCO. This indicates to the receiver that the following communication can be found in the International Code of Signals. Many circumstances are covered by two-letter signals. For example, INTERCO GOLF UNIFORM (GU) means it is not safe to fire a rocket.

Keep communications brief and cut out all unnecessary words.

Example 1 – vessel expected

Humber Pilot... Humber Pilot... Nautical Institute... Nautical Institute.

Example 2 – communication not expected

US Coastguard Key West... US Coastguard Key West... US Coastguard Key West... Lambeth Road... Lambeth Road... Lambeth Road.

In both examples the stations being called will recognise this and listen carefully for the name of the station. The vessel's call sign may be added, but usually it will be the other station that requests any additional information. The content of the communication can range from important, safety-critical instructions to minor matters.

Avoiding misunderstanding

If you do not understand, say so and ask for clarification.

If you did not hear the full message say:

Please repeat.

Practice positive or closed-loop reporting, which includes repeating back instructions to confirm receipt and understanding.

X-REF
See change of bridge watch, page 33.

Avoiding being misunderstood

- Keep communications short and to the point
- Use simple language that will not be misunderstood
- Confirm that your message has been understood as you intended
- Speak slowly
- Study the SMCP for message-type content
- Use message markers as shown in the SMCP
- Use templates provided for standard reports
- Use the International Code of Signals where necessary.

The International Code of Signals is an international system of signals and codes for use by vessels to communicate important messages covering safety of navigation and related matters including helm orders, positive reporting and closed-loop communications.

Traditionally, helm orders ran in the following sequence:

Captain – *Starboard 20.*

Helmsman – *Starboard 20.*

Helmsman – *Wheel on starboard 20.*

Captain – *Thank you.*

This procedure was extended to all operational communication exchanges following the *Herald of Free Enterprise* capsize and became known as positive reporting.

Bosun – *Port-side shell door closed.*

OOW – *Port-side shell door closed.*

In closed-loop reporting a final confirmation is given when the order is correct, so the appropriate communication is:

Captain – *Starboard 20.*

Helmsman – *Starboard 20.*

Helmsman – *Wheel on starboard 20.*

Captain – *Right.*

Avoiding weather and ice damage

Bad weather can cause severe damage to ships and cargo, and ice damage can sink a ship. The main dangers arising from bad weather are wave damage, possible capsize or severe hull damage. Although the decision to take action to avoid weather damage belongs to the Master, the OOW must be aware of the signs that weather is deteriorating.

Weather

Wave damage can be caused by both wind and swell waves. The height and length of the waves combined with the relative direction of encounter and steepness of the wave face will determine the effect on the ship. Waves can break over decks to create life-threatening conditions for crew members. Violent rolling of the ship from wave action will result in hazardous conditions for everyone aboard. Rolling also increases the risk of heavy equipment and cargo breaking free, which can then cause serious damage to the ship.

A ship in the Bay of Biscay in a developing storm

Two other effects of extreme weather are increased stress on the hull, causing hull damage and dangerous rolling. Hull damage can be caused when the wave length equals the length of the ship. This creates alternating maximum bending moments when first the ends of the ship are supported and then only the midships is supported. Ships have been known to crack in the midships area because of this. If the ship is pitching heavily, the pounding and slamming may cause hull damage.

Dangerous rolling, which can lead to capsize, occurs when the period of roll equals the wave period. This is known as synchronous rolling: the angle increases with each roll. Another phenomenon is parametric roll when the length of the ship equals the distance between wave crests. This is mostly limited to ships with a fine water plane area. It occurs when the relative direction is right ahead or right astern and combines with the pitching motion of the ship, affecting the righting lever parameters. When the ship is supported by large waves at the bow and stern only, if the ship rolls even a little, there will be only a small righting lever to bring the ship upright. The ship will then continue to roll until the bow and stern sections provide enough buoyancy and righting lever to bring the ship upright. These angles of roll can be very large and occur very quickly.

Altering course and or speed are sufficient to reduce all these dangerous conditions considerably. The OOW's role is to record conditions accurately in the deck logbook. It is recommended to do this every hour during bad weather, recording air pressure, wind speed and force, wave heights and swell direction. Tell crew not to go on deck and ensure the instruction is obeyed.

Ice

If ice can be avoided then it should be. Ships trading in regions affected by ice will receive special ice reports from neighbouring countries. They can make use of navigators with specialist knowledge and icebreaker assistance.

The key issue to understand is that ice can be as hard as concrete and cause tremendous damage to the underwater hull, fittings and equipment such as rudder, propeller and transverse thrusters. Some ships trading regularly in ice are specially strengthened with additional protection for the rudder and propeller. Some officers undergo specific ice navigation training.

Slush and small pieces of broken ice can block cooling water intakes. If this happens, the engine room should switch to lower suctions. Ice accretion may occur on deck and care needs to be taken to avoid stability problems. Cold weather can also cause fire lines, hydrants and window washers to freeze and become damaged, so these should all be drained before venturing into ice regions. The ship should have a cold weather precaution procedure which must be followed. If lookouts are posted outside, then they must be protected from the cold.

Navigation in ice also causes problems with position-fixing and prediction. Celestial position-fixing is very difficult because of refraction problems and a clear horizon. GNSS is problematic because of the altitude of satellites and compasses. Both gyro and magnetic are affected, and the numerous changes of course imposed by ice makes it hard to forecast the position by dead reckoning (DR). Radar may detect some forms of ice, but not all, and therefore needs to be used with caution.

Where ice is suddenly experienced in other areas, the solution is to slow down and, where possible, avoid hitting the ice.

For more information on ice navigation see *Handling Ships in First Year Ice* and *Polar Ship Operations – a practical Guide* – both published by The Nautical Institute.

Avoiding fines

A fine is a financial penalty that must be paid when a regulation has been broken. It may be issued to an individual or a company depending on the rule that has been broken. Contravention of the Colregs could result in an OOW and Master being fined. Contravention of environmental regulations could lead to both company and officers being fined. Another consequence could be suspension or cancellation of an individual's licence. In the worst outcome, there could be a criminal trial and imprisonment.

Although most of the following are the Master's responsibility, the OOW needs to have an understanding of the potential effect their actions or inaction could have.

In addition to fines, failure to comply with a regulation may result in loss of revenue for the shipowner, known as loss of hire. This can happen when a ship is detained by PSC inspectors for non-compliance with the major conventions such as SOLAS, MARPOL, MLC and STCW. Loss of hire may also result if the charterer does not accept the ship in its current condition; for instance, if holds or tanks are not sufficiently clean. Good record-keeping in the deck logbook by the OOW can help with mitigation.

A serious issue that can cause substantial loss for the shipowner is breach of insurance contracts. This could involve a breach of warranty if the ship sailed in an area excluded by the hull and machinery policy, such as the Barents Sea. Breach of warranty might also apply if the vessel puts to sea in an unseaworthy condition – for instance, if some navigation equipment listed on the safety equipment certificate was not working before sailing.

Many fines arise from contravention of local regulations, so it is important to study local rules carefully at the passage planning stage. Typical local rules include speed limits in certain sections of territorial waters or waterways, and prohibition of anchoring in certain areas or local routeing systems.

Penalties can be avoided by:

- Including local rules and information from Notices to Mariners in the passage plan
- Asking the navigator to check with the local arrival port agent
- Keeping good records of where the ship has been
- Keeping good records of the latest navigation warnings received
- Keeping good records of equipment checks performed, including any calibration
- Recording in the logbook the equipment in use, such as radars, echosounder and steering gear
- Ensuring all equipment and activities meet SOLAS, MARPOL, STCW
- Ensuring routes comply with insurance warranties
- Complying with particularly sensitive sea areas (PSSAs) and wildlife conservation areas
- Observing speed limits
- Observing reporting requirements.

In the case of radars, echosounder and steering gear any logbook following best practice will detail this equipment to ensure good record keeping:

	COURSE AND MONITORING															
Time	True	Heading			Errors		Allowances		Strg motor		Aut	OCA	CO	XTE
	CO	True	Gyro	Comp	Gyro	Comp	Set	L'way	1	2	Hand		Rc dr	
01														
02														

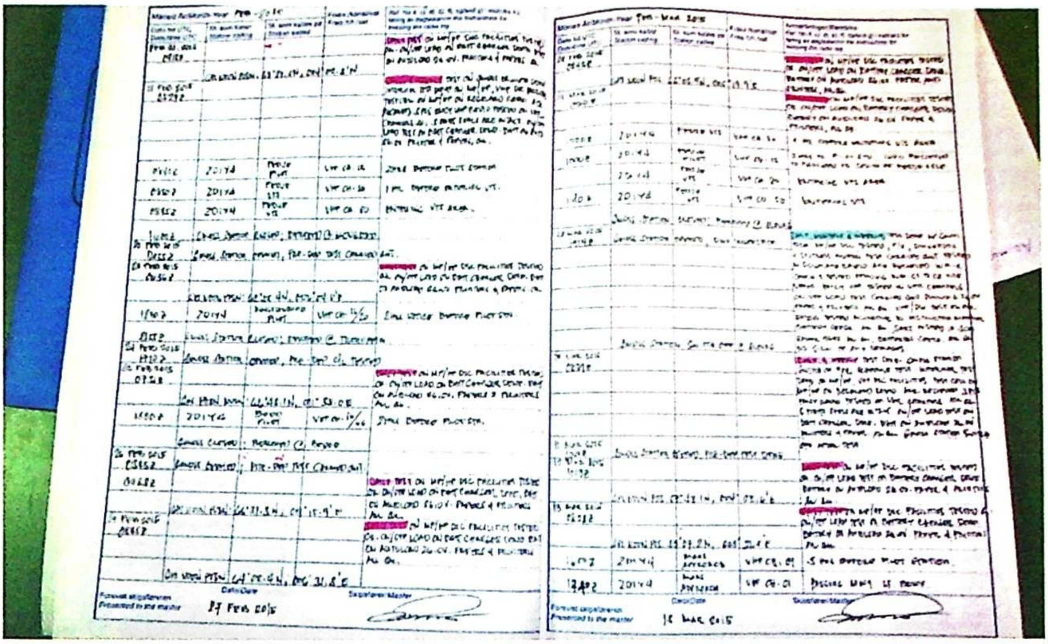
	PRIME NAVIGATION EQUIPMENT													
Time	GPS	GPS	ENC	Rdr	Rdr	VHF	VHF	AIS	VDR	E/S	Nav	RPM	Log	UMS
	1	2	P	1	2	1	2				Lts			BWC
01														
02														

Logbook daily page heading

GMDSS

An OOW will be assigned as the GMDSS or radio communications officer. Duties will include carrying out daily, weekly and monthly tests of the equipment, keeping the GMDSS logbook up to date and maintaining equipment.

In this section, reference will be made to GMDSS watchkeeping. Each watch will start with the oncoming OOW reviewing any messages recently received. Priority should be given to any distress or urgent messages and to understand the status of the incidents. Next, check any weather reports received via the Safety Net system. These will usually need to be signed as having been read and then placed on a clip. Review any safety messages, such as navigation warnings received through the system, and initial them. Read and initial hard-copy NAVTEX messages.



Completed daily pages from the GMDSS logbook

During the handover, the incoming OOW should check that all the equipment is in operational condition and the correct frequencies are being monitored. It is important to verify that alarms are not muted and are loud enough that any new alarm can be heard at the conning position.

Except when responding to distress or urgency calls, the GMDSS watch is passive, with the OOW listening out for alerts from the equipment. Entries are made in the GMDSS logbook as required by the ship's flag administration.

Cyber security

In recent years there has been a surge in the use of both information and operation technologies on board ships, especially on the navigation bridge. The Covid-19 pandemic of 2020/21 forced many shipowners to find digital solutions to problems instead of relying on physical visits by surveyors, inspectors and superintendents.

Online reporting is now common, remote interrogation of engine and machinery parameters is increasing, remote tracking of containers is almost universal and most navigation is now conducted using ECDIS and digital publications. Most of these systems rely on the internet and therefore are vulnerable if there is disruption to the system whether accidental or intentional. Without doubt, prevention is better than the cure.

The IMO defines cyber risk as a threat that may result in operational, safety or security failures because information or systems have been corrupted, lost or compromised. It urges managements avoid or mitigate risks to an 'acceptable level'. The overall goal is to support safe and secure shipping, which is operationally resilient to cyber risks. From 2021, all companies' SMS have been required to address cyber-security.

As OOW you should be aware of your cyber responsibilities, all the equipment on the bridge that could be affected by a cyber attack and simple habits to adopt to ensure cyber hygiene.

You should never:

- Use navigation bridge internet access for personal use
- Connect personal USB (flash) drives to bridge equipment
- Use non-official USB links to transfer data, such as ECDIS updates, between equipment
- Reveal equipment or system passwords to anyone without the Master's approval
- Access any messages that you are not authorised to read
- Open any attachments to messages if you do not recognise the sender
- Use any private programs, such as navigation programs, on ship's equipment.

You must:

- Follow the company's cyber-security policy
- Report suspicious messages or attachments to the Master
- Report any loss of data
- Report any abnormality in systems.

More details on cyber security are available on The Nautical Institute's website, particularly in a special edition of the free magazine *The Navigator*.

Use of checklists

Checklists are used in all sort of activities, but they are of particular value in a safety environment – and safety of navigation is of course a high priority on board. A classic example of a checklist is a shopping list that covers simple items that can be checked off when placed in the shopping bag. Lists may be more complex for other stores, and careful checks will be required to make sure the correct items are purchased.

It is the same on board ship and especially on the bridge. Some checklists are quite simple, others complex. Checklists are used when any process or procedure of more than five steps is undertaken. The checklist helps the user to remember all the steps in a procedure. The steps themselves may be numbered, with items being ticked off as they are completed and, ideally, the time each step is completed being recorded.

Checklists are especially helpful during emergencies when people become very stressed, which can lead to errors and omissions. Checklists are also beneficial when undertaking procedures that stretch over a long time and it is likely that checks will be interrupted at some stage. The checklist will make clear at what point the task should be resumed.

Many checklists also become records and are verified during audits. Some need to be kept as records because of their importance in safety management. Others are just used for what they are – a check. The fact that the checklist was used (and all items correctly completed) is entered in the deck logbook with a record like this:

Checklist NAV04 completed.

If a check cannot be completed for instance, if equipment is not functioning it is important to report and record this immediately. For example:

Forward whistle defective.

To complete a checklist, items should be read out by the OOW and acknowledged by another officer or the rating saying the word *"check"*. This exchange will be recorded on the VDR. Checklists are usually laminated or held in hard card cases, but in future they are likely to be digital.

Many industry standard checklists are routinely used on board ship while others are available for use in emergencies. Companies often amend standard checklists to tailor them to their particular needs.

CAUTION
Do not fill in the checklist without ensuring each step has in fact been completed. Filling in the list is not the important part – completing all the procedures is.

Pre-departure checks

When a ship sails from port, there is a change in the phase of operations. It is at these changes of phase when many mistakes or omissions are made. Officers and crew will have to switch their priority from watchkeeping in port to watchkeeping at sea. Equipment and instrumentation that was shut down or in a static phase for some time might have become stuck and may not operate properly. Pre-departure checks are therefore critical.

Most ships will have a standard routine for when equipment is tested which might be one or two hours before scheduled sailing time. Sometimes equipment is tested at different times – the steering gear within 12 hours of sailing and other equipment at a later stage.

The objective of the checks is, of course, to make sure all equipment is functioning and that information is synchronised before the ship starts to move and the equipment is needed.

Sailing time

On some ships the time the ship is due to sail is known well in advance, others have only an approximate time until an hour before sailing. The Master and CO will advise a time for testing navigation and bridge equipment. Instructions will be given for when to call the pilot, if required, and whether they will board the vessel from ashore via the gangway or from the pilot boat via the pilot ladder.

Gear testing

Most cargo vessels have a Master and three officers – Chief, second and third (deck, navigation or nautical depending on the term used in your country). The CO usually deals with cargo matters in port, with port watchkeeping split between the second and third officers. Who has responsibility for testing the bridge equipment will depend on the individual ship. If a change of watch is due, the off-duty OOW will probably be called to test gear, allowing the duty OOW to finalise cargo operations. In the middle of a watch, the duty OOW may perform the tests and leave the off-duty OOW to gain maximum rest.

Pre-testing activities

Testing some of the bridge equipment is a team effort and requires the participation of members of the engine department, who will also have their own equipment checks to carry out. Liaise with the Engineer Officer of the Watch (EOOW) to arrange to test gear and advise them of timings. Testing might take place an hour before sailing, although some companies ask for tests to be conducted well before that.

Before proceeding to the bridge, the OOW should check that the rudder, propeller and any thrusters are clear of any obstructions and especially that there are no swimmers or small boats nearby. The OOW should check if a pilot has been arranged and, if so, how they will board the ship. Pilots may arrive by car or by pilot launch. If by launch, the pilot ladder must be prepared in advance. Mooring winches should be checked as operational.

The ship's security plan measures must be in place and, where required, a stowaway search conducted. It is useful to have one of the duty ABs on the bridge for the initial tests and a cadet, if one is carried, for the steering gear test and compass repeater alignment checks.

Performing tests and checks

Tests and checks are usually conducted according to two checklists: the steering gear checklist and the pre-departure checklist. The first step is to synchronise clocks with

A TYPICAL BRIDGE CHECKLIST

NAVCKL.07 BRIDGE DEPARTURE

Detail	Check
Has the following equipment been tested, synchronised and found ready for use?	☐
Clocks synchronised with engine room	☐
Bridge and engine room telegraphs and rpm indicators	☐
Controllable-pitch propeller controls and indicators, if fitted	☐
Emergency engine stops	☐
Thruster controls and indicators	☐
Communications with engine room and steering gear compartment	☐
Steering gear, including manual, autopilot and emergency changeover arrangements	☐
Rudder angle indicators	☐
Gyro, magnetic and transmitting magnetic compasses	☐
Radars	☐
Echosounder and, if fitted, recorder	☐
Speed and distance log	☐
Electronic navigational position-fixing systems (GPS etc)	☐
ECDIS	☐
AIS updated for this voyage	☐
VHF and handheld radios	☐
Communications systems (telephones and public address system)	☐
Navigation and signal lights, including alarms and spare bulbs	☐
Navigation shapes	☐
Searchlights, all-round signalling light and Aldis light and battery	☐
Sound signalling apparatus, including whistles, bell and gong	☐
Window wipers, clear view screen, window washers and heating	☐
Windows clean	☐
Bridge movement book, course and engine order recorder	☐
Passage plan prepared for the intended voyage	☐
Anchors, windlass, winches and deck power available	☐
Pilot ladders and door checked for pilot disembarkation	☐
CO to report	☐
All cargo secure in accordance with the cargo securing manual	☐
All cargo handling equipment, including cranes, secure	☐
Hull openings closed and secured and vessel watertight	☐
Tanks sounded, draughts read and stability calculated	☐
All cargo details and documents available on board	☐
All visitors ashore and crew on board	☐
Ship secure for sea	☐

the engine room and test both telephone communication modes with the ECR. The telegraph is then tested under engine control setting. Once that is done, the duty engineer starts steering gear checks (see section below on special notes). The EOOW will then continue with the ER pre-sailing preparations. The OOW undertakes the remaining pre-sailing checks, reporting to the Master once they have been completed.

Testing the main engine

The engine can be tested on air or fuel. A test on air allows the engineers to confirm that the various parts of the main engine are moving correctly. A test on fuel also provides checks on the full system. Always check the propeller is clear just before the test.

High-powered engines may have a large initial surge of air to ensure the pistons move enough to fire the engine. This can cause ships to surge ahead on the berth. Worse still, if the fuel system comes into operation, the mooring lines could break and the vessel could cause damage to other ships or port equipment. Always check both company procedures and the Master's Standing Orders to see if testing the main engine on fuel is allowed while the ship is alongside and, if so, what precautions are to be taken.

CAUTION
Always check if testing the main engine on fuel is allowed while the ship is alongside and, if so, what precautions are to be taken.

New ship leaving the shipyard

Apart from sea trials, when shipyard employees will mainly be the ones to test equipment, there will be no previous experience of testing the equipment. The shipyard will give some instructions. It is therefore necessary to carry out some trials to test operational controls. Be prepared for something not to work.

Leaving drydock

Be especially careful to carry out thorough checks after drydock. Instruments may have been disconnected and not put back in full operational condition.

Steering gear tests

This is one of the most important tests before sailing from port. The rule governing steering gear can be found in SOLAS, Chapter 2, Regulation BB. It follows that most merchant ships are fitted with two or more identical power units (Regulation 29-6.1). These tests refer to a ship fitted in this way.

Steering gear testing is set out in SOLAS, Chapter 5, Regulation 26. If you refer to the very first part of the regulation, paragraph 1, it states that "the test procedure shall include, 'where applicable' the operation of" and then lists the tests to be carried out, which includes the auxiliary steering. Therefore, if the steering gear being tested has two or more identical power units, it does NOT have an auxiliary steering gear.

Tests fall into two categories: routine and emergency. Routine tests are carried out before departing or arriving at ports. Two people are required to test the steering gear – an OOW on the bridge and an EOOW in the steering gear compartment. The test can be undertaken up to 12 hours before departure, but in practice it is undertaken about an hour before sailing. Emergency tests must be carried out at intervals not exceeding three months and recorded in the logbook.

Usually, the EOOW is advised of the time for pre-sailing tests. Before any tests are undertaken, a check is made to ensure that nothing and nobody is in the vicinity of the rudder and propeller. After the engine telegraph is tested, the EOOW goes to the steering gear compartment. Once there they call the bridge on the hand-powered telephone system. The OOW answers this call and hangs up and then calls the steering gear compartment on the automatic phone. When the EOOW answers, the basic plan of the test is then outlined.

Starting with pump number one, the ship's wheel is placed hard a port, with confirmation from the EOOW that the rudder has physically reached this position. The OOW verifies that the rudder angle indicator confirms this. The wheel is then placed hard a starboard and the time taken for the rudder to reach starboard 30° is measured. Note that at 30° an automatic slowdown feature engages to prevent mechanical damage. The time taken is recorded and compared with the SOLAS requirement and the EOOW confirms the rudder is in the hard a starboard position. The wheel is now placed amidships and the EOOW confirms when the rudder is in this position.

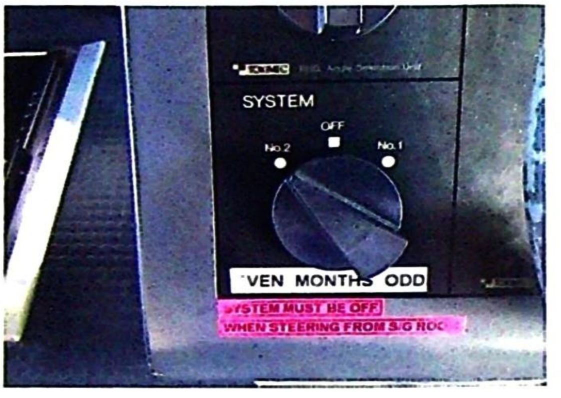
Now the second steering motor is turned on and all these steps are repeated using the two motors together. When the second stage test is complete, the first steering motor is turned off, leaving number two only and all the steps are repeated once again and recorded.

A final check is then made to confirm that rudder angle indicator readings at intermediate stages are correct; for example, by putting the wheel on port 10, port 20, midships and starboard 15. The OOW cross-checks with the EOOW the actual rudder angle and the indicators on the bridge.

The EOOW now takes control from the steering gear compartment and turns off motors locally. This should sound the remote steering gear power unit alarms on the bridge. The EOOW tests the steering gear power unit alarms and then starts up the emergency system, operating the rudder to port and starboard and confirming to the bridge as each step is reached. Once these tests are complete the EOOW will turn off the power and advise the bridge to take control again.

Usually both pumps are restarted. A check on the autopilot is now made and the course set to port, first observing the rudder response. The autopilot is then set to starboard and the rudder movement confirmed before the set course is reset to the ship's head. Finally, the non-follow-up (NFU) tiller is tested with the system still in automatic pilot. Once this is confirmed, the system is returned to manual or hand.

A typical steering console



The steering system selector switch

The basic test is now completed and the EOOW can be released when they have confirmed that there are no hydraulic leakages, no abnormal mechanical noises and that a visual inspection of the steering gear and linkages shows no apparent defects. Further tests may be conducted using bridge personnel only.

The steering gear equipment fitted to unconventional ships will differ and therefore the SMS should be consulted for the steering gear checks to be performed. If the ship has other remote control stations for the operation of the steering gear (eg on the bridge wings), these can now be tested. A steering gear test checklist will ensure all steps are carried out.

A TYPICAL STEERING GEAR CHECKLIST

Port:______________ Date:______________ Arrival/departure______________

Condition______________ Loaded/ballast ______________ Draught______________

Ancilliary checks	Time	
Communications	__________	Hand-powered phone
Communications	__________	Automatic phone
Gyro repeater	__________	Steering
Gyro repeater	__________	Steering compartment
Rudder angle indicator	__________	Helmsman
Rudder angle indicator	__________	Deckhead
Rudder angle indicator	__________	Port wing
Rudder angle indicator	__________	Starboard wing
Pump indicators	__________	On control panel
Power alarms	__________	On control panel

Pump #	H = hand A = auto	System #		Duration(s) 35p-30s	Time complete
1	H	1		**	
1	H	2		**	
2	H	2		**	
2	H	1		**	
1 & 2	H	1			
1 & 2	H	2			
1 & 2	A	2	NFU test in aut		
1 & 2	A	1	NFU test in aut		
Engineer turns off from steering flat, then turns on locally					
2	Local	Emergency			
Engineer now turns off locally and once done the bridge now turns on again					
Engineer confirms no defects					
Test completed and recorded in logbook					

** It is not required to record the time taken for a single motor, but it is best practice.

Notes – For this ship the above tests include the following: 1 Test of main steering gear; 2 Remote steering gear control systems; 3 Steering positions on the bridge; 4 Emergency power supply; 5 All rudder angle indicators; 6 Steering gear power failure alarms; 7 Automatic isolating equipment; 8 Visual inspection of steering gear and linkages for damage and hydraulic leaks

EMERGENCY STEERING DRILLS SHALL BE CONDUCTED AT INTERVALS NOT EXCEEDING THREE MONTHS.

A mini wheel on the main console

A mini wheel at the bridge wing manoeuvring position

Pre-arrival tests

When arriving in port you will experience reduced margins of safety sometimes reduced to an absolute minimum. It is therefore essential that all ship's equipment is in full working order and any errors on instrumentation are known in advance so that corrections can be made and, where necessary, monitoring undertaken.

After long ocean crossings where the course and speed has not changed, equipment that has been in continuous operation may not respond to the changes ordered. This is why it is an industry requirement to carry out a series of pre-arrival checks. Tests should be carried out before equipment needs to be used – that is, before arrival at the pilot station where manoeuvring is carried out.

Some national and local regulations require tests to be carried out before entry to port or to a particular stretch of water or traffic route. National and local authorities may impose a mandatory requirement to report malfunctions and deficiencies in propulsion, steering, navigation and other equipment necessary for safe navigation. It is the Master's responsibility to ensure these tests are carried out and any malfunctions and deficiencies reported.

The usual routine is to slow the ship down progressively until it is safe to test the engine astern. As a ship slows, it is possible to test the steering gear to its maximum angle on both sides using all systems together and independently.

Most ships have a standard pre-arrival checklist stating which equipment should be tested. The objective of the checks is, of course, to make sure that all equipment is functioning and information is synchronised before the equipment is needed.

The time for testing will be decided at the bridge team pre-arrival meeting and will be shown on the passage plan. It will depend on the ship's arrival time and the position where tests can be carried out safely and in accordance with applicable regulations.

Tests should be carried out where it is safe to do them. Tests on most equipment may be carried out while the vessel is underway. Care should be taken to avoid a risk of the vessel being placed in jeopardy should equipment, such as propulsion or steering gear, fail during such a test. On the one hand, the test area must be away from shallow water or other dangers. On the other, the water should not be too deep as to prevent the anchor being dropped in case the vessel loses propulsion or steering. If there is no area to drop anchor, then the tests should be carried out far away from dangers in case the vessel becomes disabled and drifts.

Good practice is to conduct the test well away from confined and congested waters; this will also reduce the workload on the OOW and bridge team. If national and local regulations apply to pre-arrival tests in respect of position, for example before entry into territorial waters, that test must be carried out accordingly.

The OOW will test the gear and because the BWC should have increased by this time, the Master will be on the bridge. The Master will note this in the bridge order book. Good practice is to call an additional officer on the bridge to assist the OOW, either with watchkeeping or in conducting the tests. The Master should be on the bridge during tests and should preferably take the con.

A clear record of the testing of bridge equipment should be made in the deck logbook along the lines of the following examples:

All bridge and navigation equipment tested prior arrival as per US 33 CFR (Code of Federal Regulations) 164.25.

All bridge and navigation equipment tested prior arrival as per Checklist NAV 23.

Passage planning

On most ships it is the responsibility of the navigation officer – usually the second officer – to create a passage plan and submit it to the Master for approval. The third officer, or the most junior watchkeeper, often assists the navigation officer in preparing the plan. After it has been reviewed by the Master, a pre-voyage meeting is held with all the OOWs to run through the entire plan.

It is then customary for the Master and each OOW to sign the plan (if paper-based) or to sign the bridge order book (when ECDIS is used), which serves as evidence of this pre-voyage meeting. Any changes to the plan made after this time must be approved by the Master and should be announced in the bridge order book, which in turn should be acknowledged by each OOW.

Passage planning consists of four phases:

- Planning
- Appraisal
- Execution
- Monitoring.

As OOW you will mainly be concerned with the last two parts – execution and monitoring – but may also be required to assist the navigator in the planning and appraisal phases. The plan may need to be amended during the voyage for several reasons, including deviations to avoid danger, bad weather or ice or a change of orders by the owner or charterer.

New navigation dangers may be announced through Notices to Mariners, navigation warnings received via Safety Net, NAVTEX messages or any other source. These are plotted on the charts on receipt and, where this coincides with the planned track, a deviation should be planned. On ECDIS, after receipt of chart updates (usually weekly), the check route function should be used to confirm none of the new dangers affects the vessel's track.

The passage plan should indicate the points along the route where the OOW is expected to take specific actions. These actions might be to engage a second steering motor, engage hand steering, change BWC, change speed or call a VTS station. Audible and visual alerts can be created on ECDIS to notify the OOW when these actions are imminent. Once the action is completed, it should be entered in the deck logbook. On some ECDIS an event mark may be made and supported by text added via a dialogue box.

The OOW should ensure the ship follows the planned track as shown on the plan, making adjustments to the heading as required and according to the Master's Standing Orders. Colregs take precedence over strict adherence to the track, and margins of safety should allow for room to avoid collision within the XTD limits. If this safety margin cannot be maintained when altering course to avoid collision, the alternative is to slow down. However, the Master's Standing Orders should be followed in this case and the Master may preferred to be called in such instances.

The ship's entire voyage will be recorded on ECDIS, if available, but records of key events during the watch should nevertheless be maintained. These will include which position systems are in use – GPS, radar/parallel index, radar overlay (RO) and PVF. In addition to monitoring the ship's position and advance along the track, the OOW should monitor UKC and CATZOC.

At all times when executing the plan, remember to:

- Always check the plan at the start of each watch
- Monitor any new marine safety information relevant to the plan
- Monitor the reliability of the ship's navigation equipment
- Monitor ETAs at critical points – most ECDIS can continuously display these
- Monitor weather conditions especially for areas prone to poor visibility
- Monitor position-fixing ability – ideally use at least two systems simultaneously
- Monitor traffic conditions.

Results of monitoring may make it necessary to amend the plan during the voyage. According to SOLAS V Regulation 34 Safety of Navigation and IMO Resolution 893-2, a copy of the plan should be available "at all times" to allow the OOW immediate access to the details. This means it should be at the conning position.

Recording navigation events

The regulation requiring ships to maintain records of navigation activities can be found in SOLAS, Chapter V Regulation 28. Detailed guidelines of what should be recorded can be found in IMO Resolution A.916(22).

The purpose of maintaining these records is to be able to re-create or restore a complete record of the voyage at a later date. The volume of historical data that can be stored by ECDIS far exceeds what could be written in a logbook and it can be played back. This regulation may change.

SOLAS Regulation V/28 requires that if navigation records are not kept in a ship's logbook, they should be maintained in another form approved by the administration. Recording should be permanent and may be handwritten, electronic or mechanical. The flag state may give an exemption from keeping handwritten data. You must be guided by your company's instructions.

There are relatively few places where records will be kept:

- Deck logbook
- Official logbook (required by some flag states)
- GMDSS log
- Bell or movement book
- Compass observation book
- Record forms (as required by the company SMS)
- Equipment calibration records
- Alternative digital formats as instructed.

Guidelines on what to record are set out in SOLAS A.916.

Before the voyage

- All data relating to ship's general condition
- Crewing
- Provisioning
- Cargo on board
- Stability and stress checks and when they were conducted
- Equipment inspections
- Steering gear, navigation and radio communication checks.

During the voyage

- Courses steered
- Distances sailed
- Position fixes
- Waypoints
- Weather and sea conditions
- Effect of sea condition on ship (rolling/pitching/taking seas on deck)
- Changes to the voyage plan
- When, where and how pilots embarked or disembarked
- Entry into TSS and compliance with reporting systems
- Navigation equipment in operation and in use
- Compass system in use (Gyro 1, Gyro 2, TMC)
- Log reading

Special events

- Death and injuries among passengers and crew
- Malfunctions of shipboard equipment and aids to navigation
- Potentially hazardous situations
- Emergencies and distress messages received

With the advance of digitalisation, we can expect to see fewer hard-copy records and more digital recordings in addition to those already on board. You should be familiar with the functions of the VDR, the ECDIS playback and screenshot availability and AIS and E/S records which may be downloaded to USB drives, if fitted, and follow company instructions.

CHECKLIST FOR NAVIGATION ACTIVITY RECORDS

Movement book – arriving/leaving port
One hour's notice of SBE to ER
SBE
All engine movements when telegraph recorder not functioning
Anchors cleared away
Pilot ladder rigged and ready (P or S)
Pilot boat approaching
Pilot on the ladder
Pilot on board (name)
MPEX completed
Pilotage started
Passing fairway buoy
Times of passing all principal buoys
Times of passing navigation marks
XTE, eg 0.1 starboard
Overtaking vessels in channels
Times of slowing down to pass other vessels on river berths
Names of tugs assisting
Which part of ship tugs assisting
Time tugs made fast, let go, dismissed
Time approaching berth or lock
Time lock gates closed
Times of first lines ashore
Times of 2+1 fast fwd and aft
Time all fast and gangway down
Time pilot left vessel
Time anchor let go
Amount of cable used (shackles)
Time vessel brought up to anchor
Time of FWE (finished with engines)

Movement book – emergencies
Time alarm sounded or alert received
Record of all actions taken
Record of all activities
Time emergency completed
Movement book – SAR
Time SAR operations commenced
Times of all SAR activities
Times when key actions taken
Movement book – reduced visibility
Time encountered
Precautions taken
Speed and any changes
Radar plot started
Sound signals started
Extra lookouts posted
Time Master takes the con
Time visibility improved
Time normal passage resumed
ECDIS in use – main or back-up
ECDIS safety settings

CHECKLIST FOR NAVIGATION ACTIVITY RECORDS

Deck logbook
Weather conditions, swell and waves
Every alter course position
At least 2 verif positions per watch
Reports submitted to VTS port control
VHF channels monitored
Times of sunrise and sunset
Taking of any water on deck - spray
Light water or heavy seas
Stability condition (arrival/departure)
Times of any ballasting operation
Times of any deballasting operation
Times when rounds made of vessel
Times of Master's inspections
Names of officers making inspections
Times of officers' inspections
Names of any company representative visiting vessel
Time of any flag state inspection
Time of any PSC inspection
Time of any class survey or audit
Names of all inspectors, surveyors and auditors inspecting, surveying or auditing the ship

Main events from movement book
Time vessel secured for sea
Time, date and brief details of any emergency drill conducted
Any pollution sighted near the ship
ECDIS unit in use for logbook use
ECDIS safety depth and safety contour settings
Time vessel enters or leaves TSS
Time second/additional steering motor turned on/off
Full record of all course and heading information

Chapter 3

Arriving on board

Familiarisation – the basics

Familiarisation is a requirement of the ISM Code. For this book the focus will be on familiarisation with the bridge, its equipment and watchkeeping activities. There are three main elements to familiarisation: safety and security, the ship's layout and those that are job-specific. The job-specific elements can be divided into watchkeeping and non-watchkeeping activities.

The emergency plan and muster list are important documents that must be displayed by law. The first shows how emergencies will be dealt with on board. The second explains the emergency signals and sets out what each person shall do when they hear those signals, a list of all the people on board, their specific duties in an emergency and their lifeboat stations.

Emergency signals are shown on the muster list, but you will also need to know where the call/activation points are in case you discover a fire or if there is any other emergency. If the alarm is activated while you are on watch, you will have to initiate the response by sounding alarms as described in the emergency plan.

The Safety Officer will conduct a familiarisation explanation with you to show you the location and operation of the lifesaving appliances (LSA), firefighting equipment (FFE) and safety equipment on board.

You will need to become familiar with the layout of the ship, know where all the main compartments are and their access points, and where the emergency escapes are located for:

- The engine room
- Steering gear
- The emergency generator room
- The CO_2 room/foam room/powder room
- Fire stations
- Store rooms
- The galley
- The ballast control room
- The cargo office
- Cargo spaces

- Pump rooms
- Cargo handling and provision cranes
- Mooring decks
- Forecastle store
- Underdeck passages
- Emergency exits and escape routes.

The CO will provide you with job-specific training, mainly about watchkeeping in port, how the cargo loading and discharging are to be supervised, how safe access to the vessel is to be monitored and when moorings are to be checked and adjusted.

You will probably have additional duties such as the routine inspection and maintenance of the ship's safety equipment, for which you will report to the CO. Additional duties may also include the preparation and updating of crew lists and crew declarations for the Master.

Familiarisation – bridge equipment

Bridge equipment can be divided into three main groups: navigation, communications and safety. Familiarisation of bridge equipment should be on a one-to-one basis. As it will take time to learn, sufficient time should be allowed for this. Some familiarisation can take place ashore before an officer joins a ship. In addition, familiarisation may be enhanced through looking at self-help videos and guides. Handover notes may contain further information that will help relieving officers familiarise themselves with the operation of equipment.

Even so, it is impossible for a newly joined officer to become entirely familiar with navigation bridge equipment in a single day in port. Support on watch from another officer will be needed until full familiarisation is achieved. This is a fundamental safety requirement. Best practice is where joining officers spend about a week on board for the handing-over process before taking on watchkeeping responsibility.

REMEMBER
It is impossible for newly joined officers to become totally familiar with navigation bridge equipment within a single day in port.

Despite looking the same, sister ships are never 100% identical. There is always something in a different location, equipment that operates differently or is a different model (even if produced by the same manufacturer).

For all equipment, you should find out where the basic power supply switches are located and where the fuses and the emergency supply breakers are in the emergency generator room. It is especially important to follow safety precautions. Do not allow anyone near radar scanners when they are operating. Remember to set tanker precautions – VHF low power alongside. Turn off AIS when alongside in port and set container ship precautions by turning off radars when gantry cranes are operating.

Familiarisation – navigation equipment

Ships are required to carry navigation equipment as specified in SOLAS Chapter V Regulation 19. This sets out the additional equipment required for different types and sizes of ship. Equipment fitted should be listed on the Ship's Safety Equipment Certificate Form E, which is usually kept by the Master.

It is important to know the location of all this equipment so it can be used quickly and effectively. You must also know how to turn the equipment on and off, the location of the isolation switches and basic operations. You therefore need to know where the instruction manuals are kept. On newbuild ships entering service, instruction manuals may be digital.

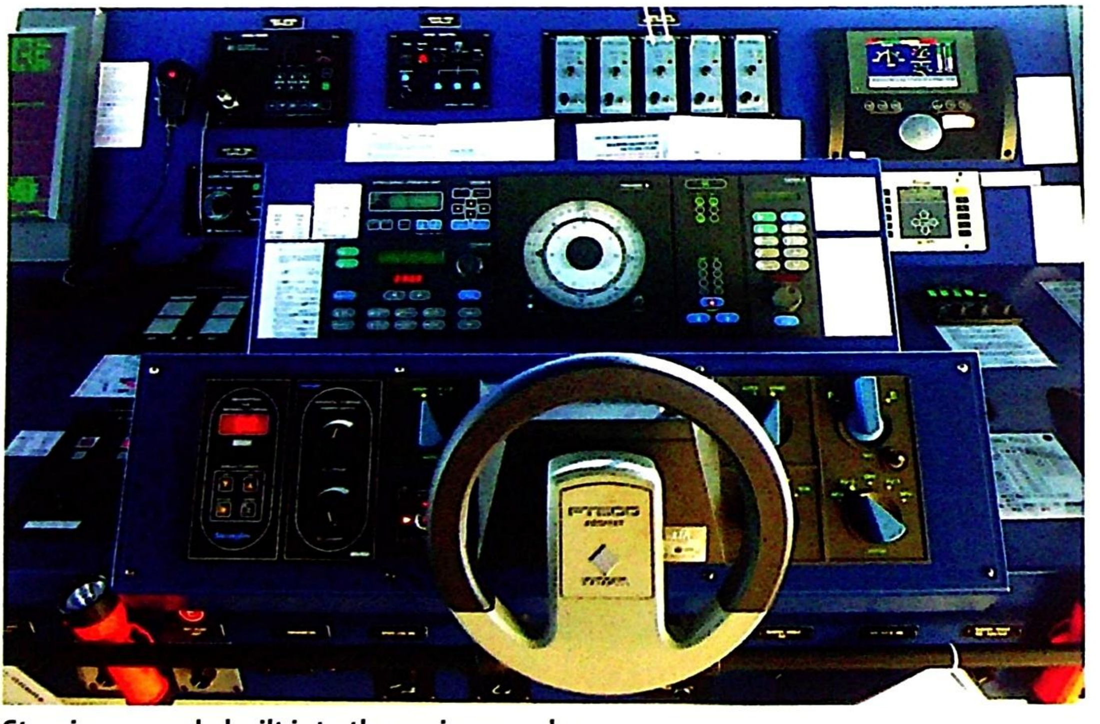
The main engine telegraph controls the speed of the ship and is very simple to operate. It will probably be fitted with a clutch or some other safety switch to prevent inadvertent operation. It will show fixed rpm settings for manoeuvring speeds of dead slow, slow, half and full ahead and dead slow astern, slow astern, half astern and full astern – ahead and astern separated by STOP.

A modern main engine telegraph and control panel

Once the ship has cleared port, full away on sea passage (FAOP) will be announced and rpm increased, possibly by using a small wheel or other device on the telegraph. On ships with variable-pitch propellers, the changes are continuous without any fixed settings. Some ships have bridge wing telegraph controls. To use them, control will need to be transferred from the wheelhouse to the bridge wing. This action usually consists of two steps – change to bridge wing on the main console in the bridge and accept control on the bridge wing console. The reverse procedure is used when changing back. RPM indicators are provided to show the actual rpm of the propeller at any time.

The helm controls the direction of the ship. The rudder is moved by the steering gear and usually operates through an arc of 70°, with 35° on each side. There are two steering gears that can be used, either one at a time or together. The power switches are located on the bridge. There are two systems for transmitting the helm orders to the steering gear, usually simply called 1 and 2. When the wheel is turned, the rudder will follow the wheel order and stop when it reaches the desired rudder angle. When the wheel is released, the rudder will return to the amidships position.

Some ships are provided with tillers or mini wheels that operate in the non-follow-up mode (NFU). When the tiller is moved, the rudder moves and when the tiller stops, so does the rudder. To return to midships, the tiller must be operated until the midships position has been reached. Rudder angle indicators are located on the steering stand and on the deckhead.



Steering console built into the main console

Except when required in an emergency, rudder angles of 20° or more are mostly used for manoeuvring purposes only.

A small blue steering light is located on the foremast to help the helmsman steer using leading lights. They can see the blue light moving against the horizon where the ship is turning. Find out where the switch is located.

It is imperative to know where the ship is heading at any time. The advantage of the magnetic compass is that it requires no power to provide this information. It is usually located on the ship's fore and aft centreline on the deck immediately above the bridge, and the heading can be observed using a periscope mounted just in front of the helmsman. Many ships are provided with a transmitting magnetic compass which displays the magnetic heading on a readout on the steering stand. Note where the light switches for the 220V and 24V emergency supply are located for this compass. Also check where the spares are located if you need to correct the magnetic compass.

A magnetic compass bowl

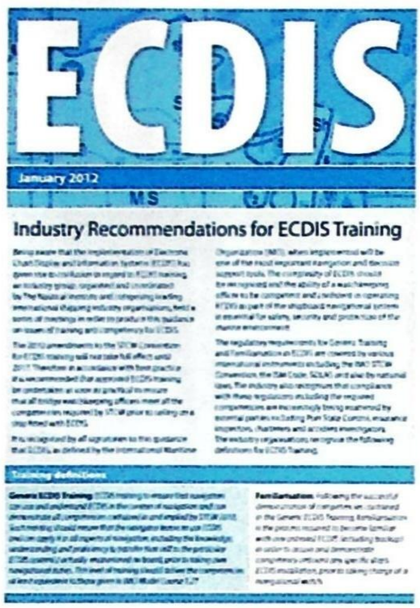
Magnetic compass binnacle

A deviation curve must be provided by a qualified compass adjuster when the ship is delivered and at subsequent adjustments of the compass. The compass is adjusted only when the recorded deviations differ by 5° or more from the original deviation curve, although this will depend on flag state rules. To confirm the deviations, the ship will be swung each year by the Master and officers and they will also prepare a deviation curve. Both should be displayed in the wheelhouse.

A pelorus, or compass bearing device, is provided for compass bearings over an arc of the horizon of 360° and is usually kept with the spare magnets.

Modern steering systems include both heading and track controls on the steering stand. Emergency override controls are also provided at various locations on the bridge to allow the OOW to take immediate control of steering until an emergency is over. This override system tends to be an NFU system – check which type is on your ship.

The term nautical charts covers ENCs used on an ECDIS, which are the accepted equivalent of paper for SOLAS Ch V, Reg 19 2.1.4. Familiarisation with the ECDIS is a long subject. An industry standard familiarisation checklist was drawn up under the guidance of The Nautical Institute with the agreement of other organisations, including the International Chamber of Shipping (ICS), the Oil Companies International Marine Forum (OCIMF) and the International Association of Independent Tanker Owners (Intertanko). This industry-approved list can be found on the website of The Nautical Institute: Nautinst.org/ECDISGuidelines


ECDIS

January 2012

Industry Recommendations for ECDIS Training

Industry guidance on familiarisation can be found on the Institute's website

Checklists to help familiarisation are in the Institute's publication *ECDIS and Positioning*, which explains why each part of this process is important. There are six parts to the familiarisation checklist. This is used on many ships as the basis for the onboard familiarisation tool with photographs, screenshots and/or menu steps to point to answers to checklist questions. You can find the guidance here at: Nautinst.org/ECDISChecklist

It is important to know the location of base CDs, if supplied, so the system can be recovered if it crashes. On the latest equipment, system recovery may be online or between onboard systems. A second, identical, ECDIS is fitted and, on some ships, even a third. Latest developments include large flat, horizontal touchscreen planning stations, which allow passage plans to be transferred to the ECDIS.

Most ships now have at least two GNSS receivers and there is sometimes a switch to allow the OOW to choose which GNSS is being used for both ECDIS. They also have:

- A sound reception system when the bridge is totally enclosed
- A telephone to the emergency steering position (for communicating heading information)
- Spare magnetic compasses, which are stowed upside down to avoid wearing down the jewelled bearing.

Window wipers, clear view screen and window heating may be basic items, but they are all essential for safe navigation. As part of your familiarisation exercise, locate the control switches and the windscreen washer valves.

An echosounder

Modern echosounders have an LCD display and a means to record soundings digitally. These can be downloaded on to USB drives. On some, recordings can be made using a special marker and the graphs and marks then downloaded to a USB flash drive.

Many paper echosounder recording displays are still in use. Find out where the spare paper is stored and how to change the roll and the ink or felt tip pens. A depth alarm facility is provided. Make sure you know how to set this alarm and what the alarm sounds like.

Familiarise yourself with the key controls for the radars. Usually two are carried: a 9GHz or 3cm known as an X band, and a 3GHz, 10cm or S band. The 10cm radar is used for long-range detection.

There will be a speed and distance measuring device. Check which type of log is fitted on your ship – it may be a Doppler or electromagnetic – and what speed it shows. This could be speed over the ground or speed through the water.

Some compasses, such as magnetic compasses, only show the ship's heading at the compass itself. Many ships are now fitted with transmitting devices that allow heading information to be sent to other navigation equipment such as heading repeaters, compass repeaters, radars/ARPAs and ECDIS. Gyro compasses incorporate these devices.

In polar regions, which are at high latitudes, both gyro and magnetic compasses become unreliable and a GNSS compass may be fitted on the ship. Although it is not a transmitting heading device, the GNSS compass may be shown on this certificate under the Transmitting Heading Device title.

AIS is one of the sources of lookout. Information is passed from the AIS receiver to both ECDIS and ARPA. The accuracy of the information provided depends on the accuracy of the information put into the AIS unit on the transmitting ship. Familiarise yourself with the location of the receiver, and if on board a tanker, how to ensure it is switched to low power in port.

The VDR is usually located in the electrical locker at the rear of the bridge. Find out where the Save button and the company's or Master's instructions for its use are located.

The bridge navigational watch alarm system (BNWAS) is designed to alert other bridge officers when the OOW has become incapacitated from any cause. An alarm will sound at pre-set intervals on the bridge, which must be cancelled by the OOW to indicate they are OK. A password from the Master will be needed if the alarm is sounded. There are three types:

- A sentinel system that resets when any main bridge equipment is operated
- A motion detection system that resets when movement is detected at the front of bridge
- A basic system that consists of alarm cancelling buttons in the front of bridge area from where a lookout may be kept.

Most larger ships carry two gyro compasses, which, along with the transmitting magnetic compass, provide immediate backup if one compass system fails. There are multiple alarms to warn if the ship is off course:

- Alarm 1 The heading is not the same as that set on autopilot
- Alarm 2 There is a significant difference between the two gyro compasses
- Alarm 3 There is a difference between the magnetic and gyro compass

All these alarms allow the user to specify when the alarm will sound, eg 5°, 10° or any other appropriate value. Manufacturers usually require annual overhauls for these compasses.

One gyro compass heading repeater is placed just in front of the helmsman and another in the steering gear compartment for use when the ship is steered from there – for emergency steering. The gyro bearing repeater is for taking bearings over 360° of the horizon. Usually there will be a minimum of two, one on each bridge wing; however, it is common to see a repeater on the centreline of the ship at the front of the wheelhouse.

A variety of gyro compass repeaters

Form E, which is attached to Safety Equipment Certificate H, details all the navigation equipment carried on board. These are the key points you should be familiar with. The day-to-day usage of this equipment is discussed in the next chapter.

This list will include rudder, propeller and thrust indicators. You need to identify and locate these indicators. All of them should be readable from the conning position. The Form E list will also cite an automatic tracking aid, although most ships now carry an ARPA, depending on size and ship type. The ARPA is one of the fundamental collision prevention aids provided on board.

Check which heading or track control system your ship has, as many ships are still not provided with a track pilot. A rate-of-turn indicator shows how quickly a ship is turning and helps to avoid over-shooting the next intended heading when making large turns.

A speed and distance indicator to show speed over the ground in a forward and aft direction and athwartships direction is a very important tool when docking large ships alongside, such as when mooring large tankers to a single-point mooring (SPM).

The VDR is the ship's 'black box'; its purpose is to assist incident investigations. It records all the main safety data, navigation equipment data and the main and auxiliary data. Data can be saved by pushing a button on the bridge and can also be transferred to a float-free cannister.

To satisfy the requirement to carry a chronometer, many ships are provided with a quartz master clock system that keeps accurate time. Errors can be monitored using the time signal. However, GPS receivers require accurate time to function, and so the time displayed by this equipment is sufficiently accurate for celestial navigation purposes.

MAERSK ROSYTH

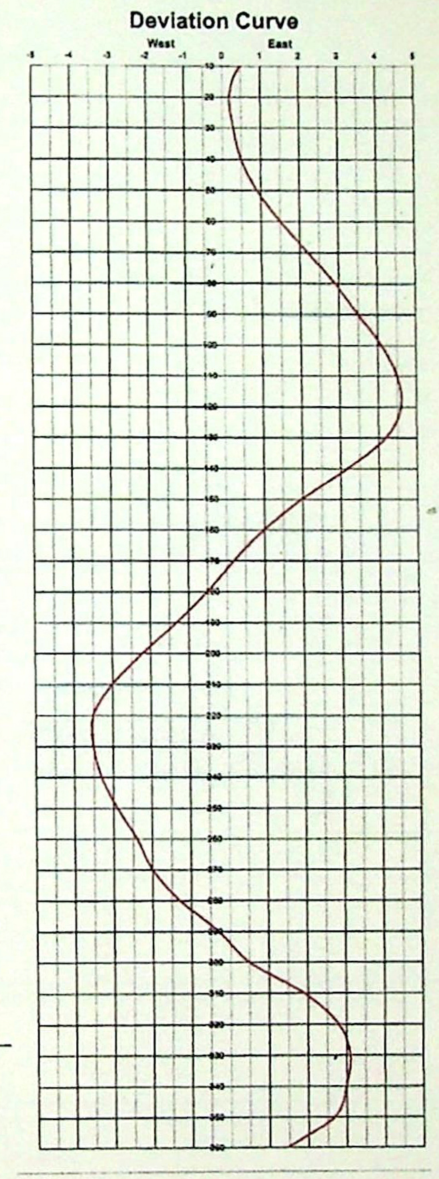
DATE: 16th July 2019
LOCATION: ODENSE, Denmark
POSN: LAT 55°34.8' N LONG 010°30.1'E
VARIATION: 3°E

DEVIATION TABLE

HEADING	DEVIATION	
0	1.5	E
10	0.5	E
20	0.2	E
30	0.3	E
40	0.5	E
50	0.9	E
60	1.5	E
70	2.2	E
80	2.9	E
90	3.5	E
100	4.1	E
110	4.5	E
120	4.6	E
130	4.2	E
140	3.2	E
150	2	E
160	1	E
170	0.2	E
180	-0.5	W
190	-1.3	W
200	-2.2	W
210	-3	W
220	-3.5	W
230	-3.5	W
240	-3.3	W
250	-2.9	W
260	-2.4	W
270	-2	W
280	-1.3	W
290	-0.3	W
300	0.5	E
310	1.9	E
320	2.8	E
330	3.1	E
340	3	E
350	2.7	E
360	1.5	E

MASTER: LENNERT P. MELCHIORSEN

2nd OFFICER : FILIP POALELUNGI



Compass deviation curve (image: Chandris Hellas)

Japan Compass Adjusters Association

CERTIFICATE FOR COMPASS ADJUSTMENT

SHIP'S NAME M/V MAERSK ROSYTH — DATE 27th Jul. 2018

STANDARD COMPASS — MAKER Spery Marine C Plath

Weather Fine Sea Moderate — Position (49.5° N, 000.1° W)

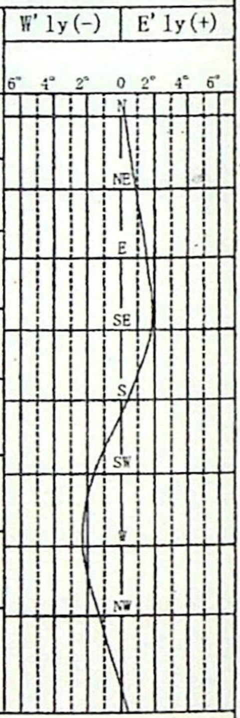
H : 20.5μT Z : 43.5μT — Variation −0.1° (0.1° Wly)

CORRECTING RECORD

			Before Adj.	After adj.
B	Flinders Bar		2pcs(22.5cm)	2pcs(22.5cm)
B	Fore & Aft Magnet	Right	R 4pcs(12, 8, 3 R:F 11 R:A)	R 4pcs(12, 4, 3 R:F 11 R:A)
		Left	L 3pcs(11, 10, 8 R:F)	L 2pcs(11, 10 R:F)
		Red end		
C	Athwart-ship magnet		3pcs(13, 9, 8)	3pcs(12, 10, 8)
		Red end	Port (St'bd)	Port (St'bd)
D	Iron Sphere	Dia.	Each Sphere(18cm)	Port Sphere(18cm)
		Dist.	P:2.0, S:1.0	P:2.0
Heeling Magnet		Piece	1pc	1pc(No. 5)
		Red end	(Up) Down	(Up) Down

DEVIATION TABLE

Ship's Head	DEV.
N	0.3
NE	0.9
E	1.5
SE	1.9
S	0.3
SW	−1.4
W	−2.2
NW	−1.1



magnetic compass status	
Bubble	No bubble
Card moving	Smoothly
Binnacle setting	Good
Others	Good

COEFFICIENT	
A	Nil
B	1.9
C	−0.1
D	−0.3
E	0.3

NOTE: This magnetic compass calibration has been done properly.

License Stamp	Adjuster's Signature	Captain's Signature
MCA 0293 SQCA	Capt. Gen Makiyama Capt. [signature]	[signature]

Many new ships don't carry a sextant – there is no requirement for one. If there is one on your ship, it is good practice to become familiar with its use. You never know when you may need to use it.

Some vessels are provided with a desktop computer that acts as a planning station, allowing navigators to do passage planning separately from the active ECDIS. The latest developments include ECDIS planning stations with large horizontal touchscreen monitors. Once a passage plan is created it can be transferred to both ECDIS units.

Nautical publications include sailing directions, lists of lights, lists of radio signals, tide tables, nautical tables, annual Notices to Mariners etc. Some publications are produced only in hard copy, but increasingly publications are available digitally including the lists of lights, tide tables, radio signals and sailing directions from most hydrographic offices. If they are provided in this format, they must be available for use on two computers. The great advantage of these digital publications is the ability to update them rapidly at least once a week. Most flag states have lists of the minimum titles to be carried on board.

Familiarisation – communications and GMDSS equipment

The GMDSS equipment provided on board will depend on the sea area the ship is expected to operate in. These areas can be found in SOLAS, Chapter IV Regulation 2, paragraphs 1.12 to 1.15. These are:

- A1 An area within the radiotelephone coverage of at least one VHF coast station in which continuous digital selective calling (DSC) alerting is available
- A2 An area, excluding sea area A1, within the radiotelephone coverage of at least one medium-frequency (MF) coast station in which continuous DSC alerting is available
- A3 An area, excluding sea areas A1 and A2, within the coverage of an Inmarsat geostationary satellite in which continuous alerting is available
- A4 An area outside sea areas A1, A2 and A3.

GMDSS equipment tends to be grouped together in a standalone console, in the chart space or at the back of the bridge. This console will be made up of:

- A VHF (very high frequency) DSC
- An MF DSC
- An HF (high-frequency) DSC
- A NAVTEX (or it may be in the chart space)
- SES (ship's satellite Earth station; usually two)
- HF direct printing.

In addition to this console-mounted equipment, a satellite EPIRB is usually installed on the bridge wing. Two search and rescue transponders (SART) are usually found just inside the wheelhouse door, one on each side; alternatively, on a ship fitted with a freefall lifeboat, one unit will be fitted inside the lifeboat. There will also be three handheld radios to be used in the liferafts or lifeboats.

Familiarise yourself with the operation of all equipment including:

- Changing frequencies
- The response to distress signals
- Messages and calls
- Urgency and safety messages
- The location of the radio station licence, which must be displayed near the GMDSS station and the GMDSS logbook.

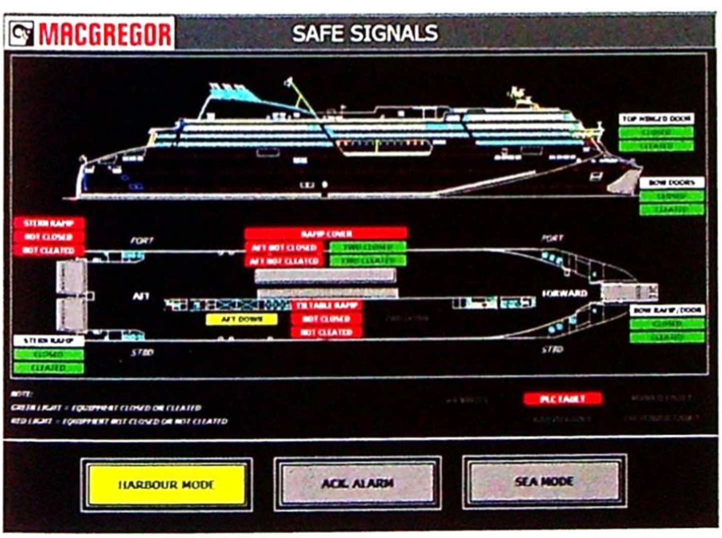
Familiarisation – emergency alarms and controls

The emergency alarms found on board will vary depending on ship type and size. Most will be on the bridge, but some ships have dedicated emergency control rooms or safety centres where the main alarm panels and controls are located. Any emergency response will be coordinated from there. The OOW should become familiar with all alarms and when they should be set off from the bridge.

All ships have a fire alarm indicator panel showing the location of push button alarms. There will also be fire detector alarms that automatically sense smoke, heat or flickering flames. Some ships have gas alarms.

Alarms will be grouped into sections depending on the type of vessel. On cargo ships the sections are likely to be accommodation, machinery spaces and cargo spaces. Some cargo ships have fire doors that close automatically when the general emergency signal sounds. Other fire doors on cargo ships should be kept closed at all times and opened only when someone is passing through. Passenger ships are divided into fire zones and the alarm indicators. The alarm panel arrangement will reflect this. Passenger ships also have fire doors and the alarm panel will indicate whether they are open or closed.

Bulk carriers have alarms to indicate significant water ingress into the hold. Most ships have bilge alarms for when water in the bilge reaches a certain level. Passenger ships are provided with watertight doors that may be opened or closed from the bridge. These will be shown on a panel with open/closed indicator lights. Ro-ro vessels will have a video camera on the car deck so the Master can confirm if the bow/stern door is closed or not. There will also be panels for the hydraulic interlocks for all openings.



Emergency controls include fire and bilge or ballast pump switches, and fire and watertight integrity alarms

It is essential you are fully familiar with company instructions about how the OOW should respond when any of these alarms sounds. If certain alarms are not answered within a certain time, they will trigger the general emergency alarm. This may be desirable on cargo ships to ensure the maximum response to an emergency in the shortest time possible. On a passenger ship it may be not be appropriate for all the passengers to be disturbed; instead, it may be better to isolate the particular area and to send a rapid response team immediately to investigate before escalating the response.

There should be a special alarm to alert all crew to any piracy incident. They should go to the citadel immediately if they hear it. More advice on this is contained in *Maritime Security Handbook: Coping with Piracy*, published by The Nautical Institute.

Chapter 4
Different types of watchkeeping

How bridge watchkeeping is conducted depends on the intensity of the navigation being undertaken. It will be determined by fixed conditions such as the geographical location of the ship, its size, type and navigation regulations faced. Then there are variable factors including visibility, heavy weather, severe weather, traffic density, concentrations of fishing vessels and offshore operations such as oil exploration. A third factor is whether there is an emergency. And lastly, when under pilotage, when a person unconnected to the ship joins the bridge team.

In simple terms, the more intense the navigation is, according to the number and proximity of hazards, the greater the workload on the bridge team. This in turn will require an increase in both the number in the team, to share the navigation tasks, and in the use of navigation instrumentation.

Routine watchkeeping

Deepsea or ocean navigation

The definition of deepsea or ocean navigation has become a little blurred over time so we should review what it really means in terms of watchkeeping. It refers to the distance of a ship from land and the depth of water it is sailing in. Deepsea or ocean navigation is defined as when the vessel is more than 50 miles from land and out of sight of land or shore lights. Under these conditions, it is not possible to obtain a position fix by terrestrial means. The depth of water will be 200m or more.

The definition includes other characteristics: the voyage is expected to take several days, traffic will be generally light and, with some exceptions, fishing vessel activity is minimal. Ships in these conditions are exposed to the full effects of the weather as there is nowhere to shelter. They are far from natural dangers such as shallow water, and reefs and wrecks do not pose a threat. Alterations to course are few but note that crossing the Bay of Biscay or parts of the Mediterranean would not count as deepsea or ocean navigation.

Position fixing will be by either satellite or celestial navigation. Monitoring of the passage plan will require a lower frequency of position fixing – perhaps only once each watch. Collision avoidance will be occasional due to fewer encounters with other traffic and, in daylight hours only, the OOW may be the sole lookout.

Margins of safety will be large and the ship will not be constrained when altering course. Careful observation of the weather is still required to detect the onset of undesirable conditions. Communications will be limited to monitoring for distress, urgent and safety traffic, Safety Net messages (text), position reporting and messages from the various automatic rescue systems such as AMVER (USA), AUSREP (Australia), CHILREP (Chile) and SISTRAM (Brazil).

Coastal navigation

When vessels are within about 20 miles of land and where water depth is generally less than 200m they are considered to be in coastal navigation. The coastline and features are visible and shore lights may be used for visual fixing. Natural dangers, such as areas of shallow water, might be encountered in addition to manmade dangers, including dangerous wrecks, oil platforms, windfarms, seabed pipelines and cables. Traffic density will be greater and fishing vessels, recreational craft and non-commercial fishing vessels are likely to be encountered. There are likely to be traffic separation schemes and traffic surveillance from VTS stations. Radio reporting may be required and coastal states may impose special transit and reporting regulations for specific ship types. There could be a need to alter course frequently.

The passage plan will be comprehensive and it will need to be monitored with frequent position-fixing. At least two systems should be employed simultaneously, such as GNSS and parallel indexing, to ensure the ship maintains the planned track.

X-REF
See position-fixing methods, page 55.

The echosounder should be in continuous use, with the depth alarm set to warn watchkeepers when the ship is approaching its UKC limit. The need to engage in collision avoidance measures will increase as traffic intensifies. There will be more NAVTEX messages and VHF calls to and from VTS stations, pilot services and between ships. On occasions it may be necessary to increase the BWC.

Port approach navigation

Approaches to ports vary considerably and may include elements of ocean, coastal and estuary navigation; there may be deep water all the way to the breakwater or access may be through buoyed channels. Many port entrances are marked by a fairway buoy, which usually indicates the port limit and where controlled navigation starts. A pilot might board at this location, which could be many miles offshore. From the fairway buoy a channel to the port might be marked by navigation buoys and beacons.

Shallow water and underwater dangers will be encountered more frequently in this type of navigation and margins of safety will be reduced. As the vessel approaches the fairway or channel, speed will decrease from sea speed to manoeuvring rpm. Once at manoeuvring rpm, end of passage (EOP or EOSP) is notified to the engine room and, on some ships, SBE is rung. Course changes now become frequent.

The approach to the fairway buoy may be regulated with a TSS or users may be free to approach from any direction. In all cases, care must be taken to avoid close-quarters situations. This is where the margin of safety (CPA) is very small and there is a high risk of collision with other arriving or departing ships. Concentrations of recreational craft and non-commercial fishing vessels may be encountered. There will be limited ability for a ship to deviate safely from its track. Some countries, such as Australia, request recreational craft to keep out of the way of large merchant vessels, which must follow a specific track for safety. As the ship approaches the pilot station, contact should be made with the pilot and a side for pilot embarkation agreed.

It is difficult for a single officer to undertake on their own the necessary passage plan monitoring, collision avoidance and communications during this phase of the voyage, so additional watchkeepers should be called to the bridge to increase the BWC. The ship must be placed in hand steering, with speed reduction and tests on key equipment (steering and engines) made before arrival.

The Master will take the con at some point before the pilot embarkation position. This allows the OOW to concentrate on monitoring the ship's position and advise the Master of its progress. The OOW can also support the Master by monitoring the helmsman and undertaking collision avoidance reporting. The OOW should also arrange for the pilot ladder to be rigged and make pre-port entry precautions, such as clearing the anchors.

River and estuary navigation

Passages in rivers and estuaries involve navigating close to dangers. Once inside the river or estuary, the ship may be unable to turn around and reverse course. Course changes become almost continuous. Shallow water is prevalent throughout and continuous position monitoring is required. There is an increased risk of grounding and interaction if the ship moves too close to the river bank. This is made worse when negotiating large bends or when avoiding other traffic in the river channels. Leading lights, where available and visible, are used to ensure the ship remains in the deepest part of the channels. Strong currents and eddies may be encountered and require great skill to negotiate safely. As local knowledge and experience is needed, the services of a licensed pilot are engaged.

The proximity of dangers means that watchkeeping officers should employ continuous position monitoring techniques (including leading lights, parallel indexing, radar overlays) and there should be constant vigilance of the UKC.

Pilotage

In most ports worldwide the use of a licensed pilot is compulsory. Pilots have intimate knowledge of rivers and estuaries, know where dangers exist, where there are strong currents and what effect they will have on shiphandling. They are also skilled shiphandlers and aware of the local navigation regulations. At this stage, the Master will pass the con to the pilot and the bridge team will acknowledge the pilot's orders, instructions and report back to the pilot.

X-REF
For more on closed-loop reporting, see pages 37-38.

The pilot cannot navigate the ship alone and requires the support of the bridge team. The OOW now monitors these orders and ensures they are followed properly, with the ER responding to engine orders and the helmsman to wheel orders. The OOW monitors the position of the ship, advising the pilot of any movement of the ship off the intended track. If in doubt at any time, the OOW should check what the pilot's intentions are.

Variable watchkeeping

Navigation in restricted visibility

The key risk associated with restricted visibility is the inability to visually detect an approaching vessel in sufficient time to assess the risk of collision and then take action to avoid a close-quarters situation. Various rules from the Colregs take effect in restricted visibility, and they must be observed. These include safe speed, use of radar and use of sound signals.

REMEMBER
There are rules for vessels in sight of one another (Colregs 11–18) and rules for vessels not in sight of one another (Colreg 19).

How much room your ship needs to manoeuvre to avoid a collision will depend on the type and size of ship, how it is loaded and the current sea state. One ship type may need at least 2 miles to sight, identify and take action to avoid a close-quarters situation, another may need 5 miles. Two ships approaching one another end-on at 20kt will have an approach speed of 40kt. This means they close by 1 mile every 1 minute 30 seconds. If visibility is only 4 miles, they have only 6 minutes to act.

It is therefore essential in these conditions to increase vigilance by using the radars, ARPA, AIS, VHF and human hearing. By combining all these elements it should be possible to detect other vessels and avoid a close-quarters situation. To make full use of these aids, an extra officer must be called to the bridge – in other words, the BWC must be increased.

Visibility can be restricted by conditions including fog, mist, falling snow, heavy rainstorms and sand storms. See Colreg 3. It creates a situation where there could be insufficient time to take collision avoidance measures and avoid a close-quarters situation from when a target is first sighted visually.

The Master's Standing Orders must define the limits of restricted and reduced visibility for their ship, making suitable allowance for its size and speed. The OOW can then immediately start actions set out in the Standing Orders without having to wait for the Master's presence on the bridge. If at any time the ship's position is in doubt, then the possibility of anchoring should be considered.

Navigation in confined waters

The key risk during navigation in confined waters is grounding, because of the proximity of numerous hazards such as shallow water, shoals and reefs, underwater wrecks and obstructions, pipelines and offshore windfarms. It is therefore essential that these areas are identified in advance on the passage plan and measures taken to ensure the vessel is kept to the planned track.

Once identified, various elements can be added in the plan, such as expected UKC during the transit of confined waters, confirmation of CATZOC, use of the echosounder, turning on the second steering motor, display of the deep-draught signal if appropriate, and slowing to a safe speed. If appropriate, no-go areas can be marked on the ECDIS.

Methods of position verification need to be identified in advance so they can be employed when transiting the area concerned. The use of radar maps in the non-GNSS mode can provide an immediate back-up in the event of ECDIS or GPS failure. A radar-conspicuous target can be identified as one of the objects marked on the map, and then acquired and used as the reference target.

A series of parallel index marks can be utilised as the vessel transits the area and radar overlay can also provide a rapid confirmation of the ship's position.

Navigation in congested waters

Many vessels will need to transit areas of known heavy traffic or may suddenly find themselves among numerous fishing vessels. The main hazards of navigation in such circumstances are the increased risk of collision, with even the positive identification of all approaching vessels posing a collision risk. The situation is further complicated when these traffic concentrations coincide with confined waters.

In these areas, continuous monitoring of other traffic for collision avoidance will be required, in addition to very frequent position monitoring. The ability to alter course to avoid collisions may be severely limited and so changes in speed are required.

The first measure to adopt is to identify on the passage plan where there is an increased probability of such concentrations occurring: straits such as Dover, Gibraltar, Malacca and Singapore are examples. So too are fishing grounds in the East China Sea, Sea of Japan, Taiwan Strait and off Mauretania.

Safe speed and maximum steerage ability are essential. On most ships it is possible to control main engines and start the steering gear motors from the bridge. However, additional engine room personnel may need to be on duty to ensure full machinery plant performance at reduced speeds if there is a need to start an additional generator, for instance.

The readiness and use of navigation systems is especially important when navigating in congested waters and arriving in port, particularly if increased navigation dangers are expected. In multiple ship encounters, sometimes the simplest solution is to slow right down and let the other targets pass clear ahead. The use of decision support systems such as the trial manoeuvre on ARPA should be employed.

IMPORTANT
The purpose of this section is to highlight the increased dangers of navigation in congested waters and ensure that measures are taken so the ship is never placed in a situation of uncontrollable risk.

Navigation in heavy weather

What constitutes bad or heavy weather is determined by the size and design of the ship. For a small reefer or container ship this may be force 7 Beaufort, but for a ULCC container ship it may be higher. Ideally, the objective should be to avoid the extremes of bad or heavy weather, but frequently it is unavoidable because of the speed of approach of storms or limited sea room and speed of the ship. All ships should be able to withstand heavy weather, within the limitations of their construction, provided that the basics of good seamanship are observed beforehand.

The goal should be to ensure that the ship is prepared before the onset of heavy weather. Preparations includes advising all personnel of the forecast, securing all moveable objects, closing all doors and ports, ensuring there is additional securing on the anchors and transferring fuel to settling and service tanks.

The risks associated with heavy weather are:

- Increased stress on the ship's structure from panting, pounding, slamming or wracking
- Danger to the ship from synchronous and or parametric rolling
- Difficulty or impossibility of maintaining intended course and speed
- Danger of waves breaking on deck
- Increased hazard to personnel from pitching and rolling
- Increased risk of moveable objects causing injury to personnel and damage to the ship and its fittings
- Difficulty in operating certain machinery through loss of suction
- Difficulty in fuel transfers
- Difficulty in detecting other ships at an early stage – small vessels hidden in the wave troughs
- Increased fatigue of all persons on board.

No matter how big a ship may be, the forces of nature are very powerful, especially the effect of waves. In heavy weather, extreme care must be taken to avoid damaging the ship and cargo. This is especially important on large ships with the accommodation and bridge located aft a long way from the bow. Those serving on bulk carriers must be particularly careful not to take heavy seas on deck forward to avoid catastrophic damage to the hatch covers. Although the motion may feel comfortable, this could give a false sense of security and may not prevent pounding or wave damage forward.

Extreme weather conditions tend to be of short duration, but nevertheless extreme measures need to be adopted to safeguard lives, the ship, the environment and the cargo. This may require suspending the voyage and heaving to – when speed is kept to an absolute minimum to maintain a safe heading. This heading will vary depending on ship type and may range from putting the largest waves right ahead to putting them just forward of the beam. Every ship will have its own natural heading when the speed is reduced to zero. If the engines are stopped, it will lie a hull.

Many ships are now weather-routed on ocean passages by shore service providers that can provide detailed weather forecast data. A track is decided for the ship that may provide for the least time, least damage or least fuel consumption. Routeing instructions will go either to the Master or direct to the bridge planning computer.

Navigation in ice

If ice is sighted, the Master should be informed immediately and the engine room notified. Ice can damage the hull, rudder and propeller. Speed reduction is recommended. Ice report broadcasts should be monitored and danger messages should be transmitted in accordance with SOLAS.

In addition to ice navigation precautions, the OOW should implement cold weather precautions such as draining fire lines.

Emergencies during navigation

The average ship spends about 70% of its time underway at sea, and during that time the navigation bridge is always crewed by at least one person. It is for that reason that most alarms are on the bridge, so there will be an immediate response during an emergency. Even when the navigation bridge is not staffed, there will be an automatic relay of the alarms to the general emergency signal.

During an emergency the bridge becomes the control centre because of the proximity of the alarms and communications equipment. The emergency may be internal (affecting only your own ship), external (involving another person, ship or aircraft), or a combination of the two. Most emergencies happen without warning and the OOW is responsible for initiating actions as soon as trouble becomes apparent. To do this effectively, the OOW must be familiar with shipboard emergency contingency plans and the initial actions to be taken when an emergency arises.

It is of utmost importance that the OOW can differentiate between all the diverse emergency alarm signals because the initial action taken depends on the type of signal received. There are internal alarms common to all ship types, such as fire alarms, and others specific to the type and operation of the ship. On passenger ships there will be watertight and fire door alarms; bulk carriers have water ingress alarms; and tankers have tank high-level alarms.

There are internationally established signals for ships and aircraft in distress and that require immediate assistance. Some of these signals will be audible, some supported by text and some only visual. A rescue signal table will be displayed on the bridge explaining visual signals. It is essential that the rating providing lookout is familiar with this table.

Usually there is an emergency contingency manual (ECM) on the bridge that describes, step by step, what should be done when a particular type of emergency occurs. The first thing the OOW should do is take the ECM manual, consult the page covering the type of emergency being faced and start recording all actions taken.

One of the obvious actions to take in any emergency is to call assistance to the bridge – usually the Master. When recording events, make a note of the time the alarm was first sounded. If the general emergency signal has not sounded, then the Master may be called by phone or the BNWAS. Some emergencies require an immediate sequence of actions.

Man overboard

An example of an emergency requiring prompt action by the OOW is man overboard. It is essential to recover the person who has fallen in the water as soon as possible and a series of actions must be taken almost simultaneously by the OOW. These include:

- Deploying the MOB buoy and signal
- Sounding the MOB signal on whistles and alarms
- Turning the ship around on to the reverse course (Williamson turn)
- Noting/plotting the ship's position
- Posting extra lookouts
- Broadcasting an urgent message to nearby ships.

Many new ships have automated functions for some of these actions such as the event mark on the ECDIS and an MOB function on the autopilot.

A distress signal and message may be received by GMDSS. The company instructions should be followed as laid down in the emergency contingency manual and per the Master's Standing Orders. Usually this will involve acknowledging receipt of the signal or message and then determining the ship's ability to assist. Good records need to be kept in the GMDSS logbook. Distress signals may be seen visually and, if this is the case, records should be kept in the bridge movement/bell book of all actions taken.

Safe navigation must continue during emergencies, so the OOW should ensure that collision and grounding avoidance is not overlooked while dealing with alarms. At some stage the Save button must be activated on the VDR. This should not be done immediately the alarm sounds but one or two hours later to show the follow-up action taken on board.

The OOW responsibility for the safety of navigation continues until relieved by the Master or another officer as detailed in the muster list. Once relieved, the OOW should go to their assigned emergency squad.

Chapter 5

Using and checking navigation and bridge equipment

Bridge and navigation equipment are part of bridge resource management. Most equipment is turned on before leaving berth and left running until the ship docks at its destination. As this equipment is essential for safe navigation and forms part of the team, regular checks must be conducted to ensure data are correct and that equipment is operating as intended.

Throughout this section, notes will be provided in this format:

Start-up	How equipment should be started and tested before use
Use	When and why equipment is used
Checks	When and how equipment should be checked
Maintenance	What maintenance should be carried out and how often
Associated equipment	

Great care must be taken when dealing with ever-increasing amounts of information received on the bridge, as it is easy to be confused by the displays. The choice of display mode is at the discretion of the OOW, but they must be harmonised. For example, radar and ECDIS display modes can be head-up, course-up or north-up. If you choose north-up on radar, then north-up should be used on ECDIS.

It is also possible to have collision avoidance information provided by AIS or radar, and for it to be displayed on both sets of equipment. It is essential that the OOW knows the source of the information to ensure the correct action is being taken. You should know if speed is displayed through the water or over the ground. Note: Doppler logs can provide both. Always refer to the maker's instruction manuals.

Main engine telegraph and rpm indicators

Most ships' engines today are bridge-controlled, which means the telegraph on the bridge directly operates the main engine. This can be disabled when in port while control is transferred to the ECR.

Start-up
Usually on at all times in either ECR or bridge control mode.

Use
The main use is during manoeuvring, when frequent changes of speed are required. For speeds above manoeuvring full ahead, the telegraph may be placed directly to any position up to full sea speed. Load-up and slowdown programs may be installed to increase or decrease speed incrementally over a set period to protect against thermal shock. For small incremental adjustments, a small wheel or similar is provided.

With the control set at ECR, the telegraph can be used in the conventional way and the command signal is sent to the ECR. The engineers then adjust the main rpm according to orders received from the bridge.

Rpm indicators show the actual rpm of the propeller at any time.

Checks
Usually performed at pre-departure tests. A mark is made on recorder paper. The telegraph is moved to all positions both ahead and astern.

Rpm indicators are compared with ER indicators at noon.

Maintenance
Telegraph logger, time synchronisation on some models.

Paper to be changed as required.

Associated rpm/speed table, pitch/speed table.

Wheelhouse poster – manoeuvring diagram.

Helm

Start-up
Power switches for motors on the bridge are turned on.

Power switch for systems may also be fitted and turned on.

Use
All the time the ship is at sea.

Checks
Manual steering tested every watch at sea. Ships fitted with azimuth thrusters must also test steering in manual mode and the helmsmen must be familiar with steering these vessels by hand.

Auto pilot on every watch at sea.

All inputs should be used regularly, eg Gyro 1, 2 and transmitting magnetic compass (TMC). A system should be employed to ensure use is evenly divided. For example, Gyro 1 on odd days and Gyro 2 on even days.

Maintenance
Occasional checks by technicians.

Associated
Block diagram, auto and manual change-over instructions and the wheelhouse poster/manoeuvring diagram. These are provided to assist the OOW understand the changeover procedures and both the turning circle and stopping distances of the ship in various conditions.

Auto pilot

Heading or track control system.

Start-up
On/off switch on the steering stand.

Use
At sea when underway and clear of navigation hazards.

Checks
Once each watch at sea. Check load or ballast condition, off-course alarm setting and maximum rudder angle.

Maintenance
As for helm.

Associated equipment
Course recorder.

Rate-of-turn indicator

Start-up
Always on.

Use
For controlling large alterations of course on ships with limited room to manoeuvre.

Rudder angle indicators

Start-up
Always on.

Use
Always on and to show the actual position of the rudder.

Checks
During pre-sailing checks and thereafter once each watch. Alignment is checked against the actual position of the rudder.

Steering light

A small blue light is located on the foremast to help the helmsman steer using leading lights.

Start-up
Simple on/off switch.

Use
In rivers and channels to help the helmsman steer by leading marks.

Checks
With pre-departure and pre-arrival checks.

Maintenance
Replace bulb as required.

The standard magnetic compass

Start-up
Always functioning.

Use
At all times at sea.

Checks
Compass errors should be checked at least once every watch.

Maintenance
Check for air bubbles and if required top up with supporting fluid.

Confirm illumination is working.

Deviation curve

A deviation curve is prepared by a qualified compass adjuster when the ship is delivered. It shows the deviations in a graphical format. A new one is prepared – again by a qualified compass adjuster – when it is necessary to adjust the compass. This is required when the magnetic compass becomes unreliable, following any structural repairs or alterations that could affect the performance of the compass or where new equipment has been installed close to the compass.

Start-up
Displayed close to the magnetic compass periscope in the wheelhouse.

Use
To enable the true course and bearings of objects to be determined.

Checks
Compass error determined every watch and compasses compared frequently.

Maintenance
It is best practice to swing the ship once a year and draw up a curve of deviations on board. Provided there is no appreciable difference from the original curve, the compass does not require adjusting.

Magnetic compass, swinging, calibrating and adjusting

SOLAS mandates that every ship possesses a properly adjusted magnetic compass (SOLAS V19 2.1). It is also requires a means of taking bearings over an arc of the horizon of 360° – normally an azimuth circle which may be interchangeable with one able to be used on gyro repeaters.

Under STCW A VIII Part 4.1 Regulation 34.2, the compass error must be checked at least once every watch at sea and after each large alteration of course – say 30° or more. The results should be recorded in a compass error logbook.

Swinging

This is the process of turning the ship slowly around through 360°, keeping it on a steady heading at, say, intervals of 10° and comparing the compass bearing of a known fixed object against the true. Comparing the two enables the deviation to be determined on any heading.

Calibrating

This is the calculation of the various coefficients of magnetism affecting the compass that allow a qualified individual to adjust the compass. This is done by using magnets (fore and aft as well as athwartship) and soft iron pieces (Kelvin's Balls and Flinders Bar).

Traditionally, if the compass deviations did not vary from the deviation curve provided by the adjuster, there was no need to adjust the compass. This depended upon maintaining good records of compass errors already mentioned. Ships now conduct a swing made by the Master and create a new deviation curve, probably once a year.

The requirements for adjusting the compass vary and you must check the rules of your ship's flag. Some, such as the Isle of Man, specify the traditional method; others, such as the Marshall Islands, follow the ISO requirement – ISO 25862:2019 (E) – which calls for adjusting every two years. Some counties, such as Australia, specify three or four years.

The compass should also be adjusted under these circumstances:

- On a newbuild ship
- When a new compass is fitted
- When the ship is out of service or stopped for a long time
- When on any heading the calculated deviation exceeds 5°
- After a major incident affecting the ship's magnetism, such as lightning strike, grounding or fire
- When the compass becomes unsatisfactory or unreliable
- When there is no evidence that regular compass deviations have been obtained
- After alterations and additions to the ship such as new radars, electrical equipment, and structures
- After welding, cutting, grinding repairs etc that may affect the compass
- When electrical or magnetic equipment close to the compass is added, removed or altered

- When compass deviation does not appear to correspond with that shown on deviation card
- When the validity period of the deviation card set by the national or state marine authority is due to expire.

Spare magnetic compass

Start-up
Not applicable.

Use
To replace the standard magnetic compass if it is damaged.

Check
Compass error should be determined once each watch at sea and recorded. Deviation should then be calculated and compared against curve.

Maintenance
Occasional checks to ensure there are no air bubbles. Stow upside down.

Gyro compass

Start-up
Except when it is being serviced, the gyro compass is left running at all times. When stopped for service and then turned on again, it must be left running for several hours to allow the compass to settle down.

Use
To provide heading information and bearings of objects.

Checks
Frequently compared with the magnetic compass and error is determined once each watch. Check auto connection for latitude and speed connection.

Maintenance
As per manufacturer's instructions. For liquid-filled compasses, it is essential to follow the maker's recommendations regarding replacement of the supporting fluid.

Repeaters

Found at the steering position and bridge wings. A centreline repeater may be provided.

Start-up
Left running.

Use
For steering the ship on the required course and taking compass bearings of terrestrial and celestial objects.

Checks
Alignment with master gyro.

Radars

9GHz (3cm) and 3GHz (10cm).

Start-up
Radars are usually placed in standby mode to warm up. After a suitable time and after checking the scanners are clear, they are placed in the run mode.

Use
Radars are used for both navigation (position-fixing and parallel indexing) and collision avoidance (target detection and plotting).

The rules governing lookout state "by all available means". Radar is one of those means so it should be turned on and operational at ALL TIMES the vessel is underway. As the X band and S band have different capabilities, "all available" means that BOTH radars should be running. The only exception to this is when essential maintenance is being carried out. One of the radars (if two are fitted) may be turned to standby while the vessel is at anchor. A vessel with more than two radars may turn off one at sea provided that one X band and one S band are in operation and that there is good visibility.

The following precautions should be taken using radar:

Colreg 6
- Limitations of the radar equipment
- Range scale in use (how far ahead can you see on the scale in use?)
- Effect on radar detection of sea state (sea clutter), weather (heavy rain or snow) and rain clutter
- The possibility that smaller vessels, ice and other objects floating in the water may not be detected in sufficient time
- The influence on safe speed by the number, location and movement of detected vessels
- The influence on safe speed via the more exact assessment of visibility provided by radar

Colreg 7

- Radar shall be used properly, including long-range scanning and early plotting carried out to determine risk of collision
- Assumptions shall not be made on the use of scanty radar information

Colreg 19

- Display: may be north-up, course-up or head-up
- Shall be the same display mode as used on ECDIS
- True motion or relative motion
- True vectors or relative vectors
- If using off-centred display, frequently centre the display to check for overtaking vessels
- Long-range scanning: range can be increased occasionally to detect presence of vessels. When using two radars, one can be set at a longer-range scale

Checks

The heading marker on the radar should show the same heading on the circumference scale as the heading of the ship. Also check that the heading marker is showing 'right ahead' and not to port or starboard.

These checks are essential to ensure there are no errors in the information used to plot targets and therefore determine risk of collision.

Radar picture quality This is checked by using the performance monitor, usually once per watch. Also check gain, brilliance and clutter settings.

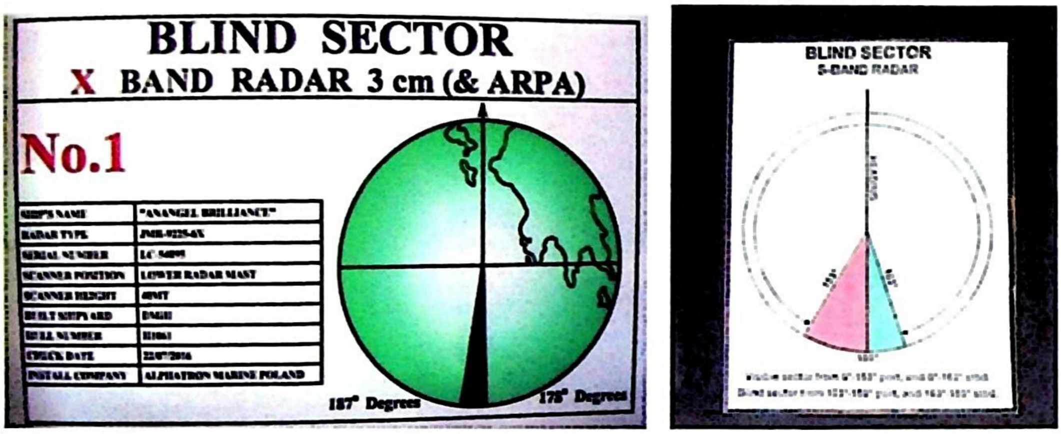
Range rings Check correct number for the scale in use.

Variable range marker Check outer edge against fixed range ring.

Electronic bearing line (EBL) Check against cursor.

At change of watch, go through all the basic settings of each radar to ensure they are set up correctly and to suit your preferences.

Check blind sectors are displayed – as the photograph shows, the radar will not detect targets in these sectors.



The blind sector of a radar

Maintenance

Apart from checks on heading marker alignment, performance monitor (PM) maintenance is usually conducted by shore technicians.

ARPA

Start-up

Simultaneously with the radar.

Use

For determining risk of collision.

Checks

A self-check should be carried out in accordance with the manufacturer's instructions.

Maintenance

As required.

ECDIS

Start-up

In accordance with the maker's instructions – usually a simple on/off switch.

Use

For displaying the intended tracks to the destination port and provide alarms and alerts for safe navigation – depth alerts and deviation from planned track.

Checks
Frequent checks required to ensure all safety settings are operative, audible and visual alarms are enabled.

Check that the layers needed for the current navigation status are displayed, such as pipelines and cables.

Check that navigation warnings are displayed (T&EP NMs, NAVTEX warnings and MSI).

The position is provided by the position sensor – usually GPS – and this needs to be verified by alternative means occasionally. The best time to do this is when a conspicuous object is visible both by eye and radar on the beam. Radar overlay can also be used.

All data inputs need to be checked regularly including course, speed and the depth of water under the keel at any time (AUKC).

CATZOC for the watch.

The scale in use (usage code) is correct for the area being navigated.

Maintenance
Presentation library.

Internal software updates from manufacturer.

X-REF
See ECDIS familiarisation, page 99.

Nautical charts

Start-up
These are installed when ECDIS is set up on board. Further licences and updates are installed online. Details of all valid licences can be found in the system.

Use
Cells are automatically selected when each passage is prepared. Usage code indicates what the scale in use is intended for.

Checks
Correct scale in use, correct layers in use.

Maintenance
ENCs: updates are applied weekly and before entering port.

GNSS receiver

GPS, GLONASS, GALILEO.

Start-up
Simple on/off switch.

Use
For providing ship's position.

Checks
Comparison between a known position (alongside) and displayed value.

Check for errors, HDOP and, in the case of DGPS, the differential station in use.

Sound reception system

On ships with a totally enclosed bridge.

Start-up
Simple on/off switch.

Use
For hearing sound signals.

Checks
Simple audio check.

Emergency steering position telephone

Start-up
Always on.

Use
For communications with the steering gear room.

Checks
At pre-departure and pre-arrival tests.

Daylight signalling lamp

Sometimes called an Aldis light.

Start-up
Can be plugged into battery supply on the bridge or to a portable battery.

Use
For attracting the attention of other ships.

Checks
Once each watch.

Maintenance
Battery charge to be checked and topped up as required.

Echosounder

Start-up
Simple on/off switch.

Use
Provides AUKC.

Should be in continuous use in depths of 200m or less.

Can be used to detect crossing the depth contours for positioning.

Checks
Should be checked against the actual depth of water when the vessel is alongside a terminal (hand lead).

Speed log

This device measures speed and distance. It is usually used for speed in the forward and aft (F&A) direction, but larger ships will also have Doppler logs displaying the athwartships speed as well.

Start-up
Usually left on at all times, except in drydock in case divers are present.

Use
To measure the speed of the vessel through the water and distance travelled by the ship.

Provides other equipment such as ARPA, ECDIS with speed information.

Checks
Comparison can be made with the DR speed from the rpm. The difference will be the slip. If the hull and propeller are not fouled, this should be about 5%.

Maintenance
Hull probes checked in drydock.

Navigation lights

Start-up
All navigation lights should be tested during pre-departure checks.

Each navigation light has two bulbs on two circuits – main and back-up. If one blows, simply switch to the other bulb. They can be powered from the mains or emergency supply. Forward light, main mast light and stern light with port and starboard side lights are provided. Anchor lights are provided forward and aft.

A second system is provided – often referred to as the Christmas tree – which contains coloured lights for use if the ship is NUC, in deep draught, aground, towing and as special lights for certain countries when the ship is carrying dangerous cargo.

Use
To show the status of the vessel whether it is underway, at anchor, aground, NUC, deep draught etc.

Checks
Pre-departure and each watch.

Checks can be made by removing fuse and one bulb.

Usual practice is to switch on navigation lights on departure and leave on until arrival in port.

AIS

Start-up
Simple on/off switch – may be protected by password.

Use
For positively identifying other ships within range. Provides course, speed and destination. Information about the transmitting ship enabling collision risk to be determined for comparison with ARPA.

Contains information about type of ship, activity and draught.

May be considered an electronic lookout.

Checks
Data can be compared with radar.

Checks are best done each watch to confirm own ship voyage and status information is correct.

Check sensor inputs and dynamic information.

Chronometer

Not a requirement. The GNSS receiver gives accurate time.

Sextant

Check
If carried, errors should be checked.

Planning station

Use
Planning the ship's passage (not found on all ships).

Nautical publications

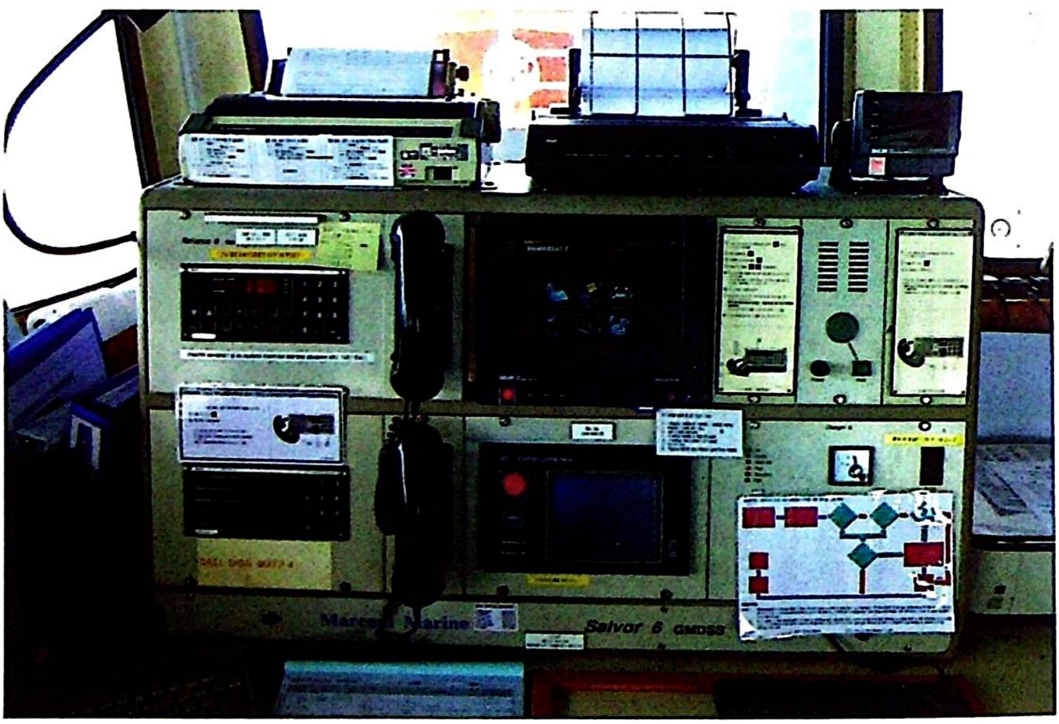
Check
Flag state's minimum titles are carried on board.

If lists of lights, tide tables, radio signals and sailing directions from the hydrographic offices are in digital format, check that they are available for use on two computers.

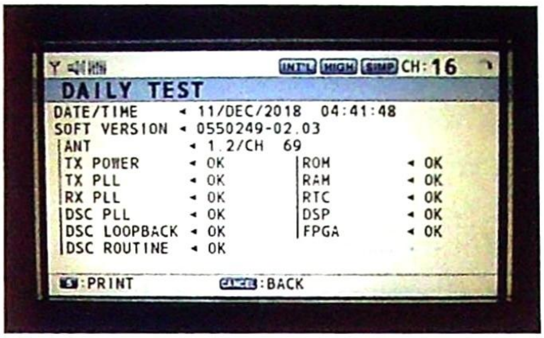
Communications equipment – GMDSS

An up-to-date shore-based maintenance certificate should be carried – issued annually.

A copy of the radio station licence should be displayed near to the station.



A complete GMDSS console



VHF

Check
Aerials, aerial connection, squelch setting, power, correct channel in use.

A VHF DSC test shown on display unit

VHF DSC

Check
Tuned to channel 70.

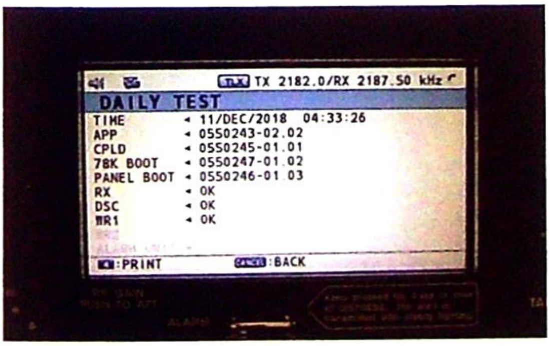
Test weekly.

The DSC controller on the console

MF DSC

Use
Guards the distress alerting channel.

Check
Tested weekly.



HF DSC

Check
Tested weekly.

The MF DSC controller

NAVTEX

Check
Switched on at least 12 hours before sailing. Check the correct stations have been set for the forthcoming voyage.

SATCOM

Check
Monthly test with shore station.

HF direct printing.

EPIRBh release unit and expiry date.

As per manufacturer's guidance, visual inspection for defects, self-test (usually monthly), check battery expiry.

SARTS

Check
If a freefall lifeboat is carried, one of the SARTS will be in the lifeboat.

VHF hand-held radios

Use
To be used in the lifesaving craft (liferafts and lifeboats).

Radio station licence

Check
It is displayed near the GMDSS station.

GMDSS logbook

This is required to be in a format approved by the ship's flag state.

Chapter 6

Performing the watch – putting it all into practice

How the watch on the bridge is performed will depend on the workload the bridge team has to do. A combination of equipment and personnel will be needed to perform the watch successfully. The ergonomics of the bridge will influence how the watch is carried out – an older bridge design will require more personnel for a watch than the latest cockpit designs.

STCW clearly states that the priorities for the OOW are to avoid collision and grounding. When margins of safety are reduced and shiphandling is required, the Master will usually take the con and, where local regulations require, a pilot will be employed. If the ship has two steering motors, SOLAS also requires they be operated when near navigation hazards.

REMEMBER
The main question to pose as a watchkeeper is "Do we have enough personnel in the bridge team and the necessary equipment in operation to carry out the watch?"

Preparation for sea

When a ship sails from port, a change in the phase of operations takes place and this is the time when mistakes or omissions can be made. Equipment and instrumentation that has been shut down or remained in a static phase for several hours may be stuck and not operate properly. It is therefore imperative that checks are made to ensure that all equipment is fully functioning before it is used. At this change of operations, officers and crew members will have to alter their priorities from watchkeeping in port to watchkeeping at sea.

Sometimes the sailing time is known well in advance, but at other times only an approximate time is known until about an hour before the ship sails. For some ship types, and in certain types of port, ships are required to vacate berths within a time limit – for instance 30 minutes after the completion of cargo operations. The Master and CO should give advance warning of the time so navigation and bridge equipment can be tested. The OOW will decide when the tests will take place and will notify all personnel involved and will give the time to call the pilot, if required, and offer information on how they will board the vessel.

It is the responsibility of the OOW to call the crew so that they are ready for departure stations. The crew is to be called or woken up by the duty deck watch for deck crew and the duty engineer for the engine room crew. At this time the OOW may give instructions for the pilot ladder to be prepared.

On a conventionally crewed ship there will be a Master and three OOWs – the CO, second and third deck officers (sometimes termed navigation or nautical officers). The CO usually deals with cargo matters in port, so port watchkeeping will be shared between the second and third officers. Which one of them conducts the bridge equipment tests will depend on the individual ship. If tests are undertaken close to the change of watch, then the off-duty OOW may be to be called to test gear, allowing the duty OOW to finalise cargo operations. If in the middle of a watch, the OOW may arrange to perform the tests so the off-duty OOW can have maximum rest.

IMPORTANT
Hours of rest requirements should be observed and any breach must be reported to the CO or Master so that remedial action can be taken.

The duty OOW must liaise with the EOOW to arrange equipment testing and inform them of the sailing time. Although testing on many vessels is often undertaken about an hour before sailing, company policies differ and some may demand that tasks be carried out in advance of this, for instance to test steering gear.

Before going to the bridge to carry out tests there, the OOW should check that the rudder, propeller and any thrusters are clear of obstructions, and ensure there are no swimmers or small boats nearby. The OOW should check if the pilot's attendance has been organised and, if so, how they will board the ship.

REMEMBER
Sometimes pilots arrive by car and sometimes by pilot launch. If by launch, the pilot ladder must be prepared in advance.

Mooring winches should be checked, as operational and security measures must be in place according to the ship's plan. Where required, a stowaway search should be conducted before departure. Details of how to carry out a search can be found in *Stowaways by Sea and Rescue of Migrants*, published by The Nautical Institute. The ship's draught should be confirmed before departure. It is helpful to have one of the duty ABs, or a cadet if one is carried, on the bridge for initial tests particularly for the steering gear test and compass repeater alignment checks.

Keep good records of the checks you make in the movement (bell) book and deck logbook. It is particularly important to do so when testing the main engine, leaving the shipyard with a newbuild vessel or leaving drydock.

The main engine can be tested on air or fuel. A test on air ensures the engineers verify that various parts of the main engine are moving correctly. A test on fuel also checks the fuel and firing system. Always check the propeller is clear just before either test.

PERFORMING TESTS AND CHECKS

The steering gear and the pre-departure checklists are generally used for tests and checks.

Step 1	Synchronise clocks with the engine room by telephone.
Step 2	Test both telephone communication modes with the engine room.
Step 3	Test the telegraph under engine control setting.
Step 4	The duty engineer proceeds to the steering gear and performs checks of the steering gear.
Step 5	The engineer undertakes the ER pre-sailing preparations.
Step 6	The OOW carries out the remaining pre-sailing checks noting any defects and reports them according to company policy.
Step 7	Once completed the OOW reports the full status of checks to the Master.
Step 8	When the pilot arrives show them the location of the pilot cabin and the bridge toilet, offer them a cup of tea or coffee and show them the pilot card.
Step 9	Notify the Master when the pilot arrives on the bridge.
Step 10	The MPEX takes place, including a mutually agreed plan, a shared mental model and signing of the relevant forms.
Step 11	Check the engine room team is ready and advise the Master accordingly.

Some high-powered engines have a large initial surge of air to ensure the pistons move enough to fire the engine. This can cause the ship to surge ahead on the berth and, worse still, if the fuel system comes into operation, the ship could move ahead and break the mooring ropes. This could cause significant damage to other ships ahead or astern and port equipment such as gantry cranes and/or loading arms.

CAUTION
Always check both company procedures and the Master's Standing Orders to confirm testing the main engine on fuel is allowed while the ship is alongside. If it is, check what precautions are needed.

When a ship is delivered from the newbuilding yard, there will be no previous experience of testing the equipment except from the sea trials. The drawback here is that most of those equipment tests will have been performed by shipyard employees. The shipyard will provide some instructions. It is therefore necessary to test the operational controls. Allow plenty of time for these tests as something may not function as expected or may not work at all.

Be extra careful to carry out thorough checks after a period in drydock as instruments – notably the echosounder and speed log – may have been disconnected and not put back into full operational condition. You will need to confirm the calibration of any new equipment that has been installed.

Pilotage outwards

This refers to that part of the voyage which includes one or all of these:

- Departure from the berth or anchorage
- Harbour navigation
- River and channel navigation
- Estuary navigation.

Pilotage can involve the use of one pilot for a short time if there is only a little distance to the breakwater exit, such as Aveiro in Portugal, or several pilots over a considerable number of hours as happens at ports such as Hamburg in Germany or Philadelphia in the USA. For most ports, the employment of a pilot is compulsory and they will be licensed by the local authority.

The pilot is external to the ship and is coming into someone else's workplace. Mutual respect is key for pilotage to be performed effectively. A warm welcome at the head of the pilot ladder and offering to carry the pilot's bag sets a good precedent on the part of the ship. There's no harm in repeating that you can get things off to a good start by offering a drink or a meal at the appropriate time.

X-REF
See also the section on pilotage, page 111.

Pilots are employed for their experience in navigating their local areas, shiphandling, the use of tugs and manoeuvring in confined waters. Pilots build up considerable experience in shiphandling and they will be graded according to their experience, with the largest and deepest-draught ships piloted by the most senior pilots. The pilot will liaise frequently with the port and river control centres, which will provide the latest traffic, meteorological and tidal information.

To function properly, the pilot needs to have the con and to be supported by the bridge team. During this time, the Master will take a supervisory role, and the OOW, helmsman and lookout will direct all their comments, observations and acknowledgement of orders to the pilot. If the Master is doubtful of the pilot's performance at any time, they may take back the con from the pilot. The pilot should not be distracted at key moments with minor requests, such as asking for their signature.

The exchange of information between the bridge team and pilot – MPEX – is therefore a critical phase and should not be rushed. Extensive information can be provided by both sides in advance, leaving only variables such as departure draughts, UKC and OHC to be advised when the pilot boards. The pilotage service could provide certain information in advance such as the waypoints for the passage from berth to pilot station. Having this information in advance will allow the navigating officer to programme the waypoints into the ship's ECDIS.

Once the last line is let go or the anchor is aweigh, the navigation lights should be switched on and the ship's status adjusted on the AIS. The ship will be in hand steering and an additional rating will be on the bridge as lookout (visual). It is usual for hand steering to be taken in turns of one hour at a time, with the lookout taking over after the first hour.

The OOW must ensure that the pilot's helm orders are followed by the helmsman and the correct course is being steered. Usually, the pilot will stand in front of the helmsman and support their orders with arm signals. All orders should be repeated back and again once the order is carried out. The positive (or closed-loop) reporting looks like this:

Pilot – *Port 10*

Helmsman – *Port 10*

Helmsman – *Rudder on port 10*

X-REF
For more on closed-loop reporting, see pages 37-38.

Engine orders from the pilot should also be acknowledged by the OOW, for instance:

Pilot – *Full ahead*

OOW – *Full ahead*

OOW – *Telegraph on full ahead*

Pilot – *Full ahead – right*

The pilot will usually bring a portable pilot unit (PPU) with them and will need to know where the connecting plug is. PPUs contain the pilotage authority's own plan, but the OOW should continue to monitor the ship's passage plan. Both plans should be the same, but this will be the case only if the ship is provided with the pilot's waypoints in advance. This is not a universal practice and so should be recorded on the MPEX form.

The pilot will want access to a radar. This can cause a problem for the OOW on some bridges where the space adjacent to the radar and ECDIS is severely limited. With the pilot at the radar and the Master at the other set of displays, the OOW may be unable to access the ECDIS and ARPA display. On a bridge with such arrangements, the issue should be discussed with the Master and preparations made in advance of pilotage and included in the MPEX.

The OOW should monitor the passage plan by checking both the ship's position and its adherence to the planned track. Report the advance of the ship in a loud clear voice that can be heard by the whole bridge team. Distances to the alter course point can be called out. Compasses should be compared frequently and transit bearings taken to check compass error. The OOW should monitor the actual UKC continuously and notify the pilot in advance if a speed reduction is required, as indicated on the passage plan.

The pilot will advise the bridge team of information they receive from ashore, such as actual tidal heights, special traffic to be encountered including deep-draught or very large ships to be passed and statutory reports to be made to VTS. Occasionally an increase in speed above manoeuvring rpm will be requested. This will be assessed by the Master and the ER notified of any limitations imposed by load-up programs. On ships fitted with load-down programs, the OOW must be aware of the ability to override such programs in an emergency.

If at any time during the pilotage the OOW is unsure of the pilot's intentions, they may question the pilot. To avoid any suggestion of conflict, remember to use the phrase "verification of intention". An example would be:

OOW – *Verification of intention, Pilot: will we slow down when we pass the next buoy?*

The vessel's position during the entire voyage will be recorded by the ECDIS at intervals specified by the user. In addition, event marks can be recorded when passing key points along the river or channel transit. These can be supplemented by parallel indexing and beam bearings and, where available, position lines from leading lights or heading marks.

Collision risks will usually be confined to overtaking or meeting traffic close to end-on. Pilots will usually seek agreement from ships being overtaken before the manoeuvre takes place. When meeting end-on, both ships will move to their respective starboard side of the channel. Both manoeuvres increase the risk of interaction and close observation will be needed to ensure countermeasures are taken in ample time.

Communications will mainly be between pilot and shore, including VTS and traffic control, tugs in the harbour region and other inbound and outbound ships. These will be recorded by the VDR.

As the pilotage comes towards an end, the pilot will advise the OOW. They will then arrange for the pilot ladder to be prepared according to the disembarkation side and the height of the lowest rung above the water. At this time, the pilot may also advise the weather conditions at the pilot station and the plan for the ship's heading and speed at disembarkation.

At change of pilot or final disembarkation, the pilot will hand over the con, usually to the Master, and be accompanied to the pilot ladder, although the OOW should remain on the bridge. A qualified officer should be in attendance to supervise disembarkation at the pilot ladder.

The coastal passage

This is the part of the voyage where the ship remains relatively close to the coastline. When the ship leaves the pilot boarding or disembarkation area, it is routine for the Master to take the con. As the ship moves away from shallow waters and the dangers they pose, speed will be increased from manoeuvring full ahead to full sea speed. Full sea speed may be modified from 95% MCR to a reduced load setting for economical consumption. The ship and bridge should be fully secured for sea at this stage. When satisfied that changes to engine speed are unlikely, the Master will advise the engine room of FAOP. On some ships there is a button next to the telegraph for this; otherwise the standby button can be used.

When there are fewer course changes, the Master will order the auto pilot to be engaged and, once satisfied this is functioning correctly, the helmsman will be dismissed. When navigation reaches the point where the Master is confident the OOW may assume the con, the BWC will be downgraded and the con will be transferred.

As the ship leaves the port authority area, a short departure report is usually made, probably to the VTS station. Depending on the ship type, additional reports, such as the Western European Tanker Reporting System (WETREP), may have to be made to the VTS station. The VHF channels to be monitored must be selected on the bridge VHF as indicated in the passage plan.

Coastal navigation will involve the use of TSS (where established). Close attention to monitoring the passage plan will be required and there must be adherence to the planned track. Acceptable limits should be shown on the plan by the XTD/XTL settings. Places where a change in safety domain values, such as guard zones, look-ahead sectors, safety frames and machinery status should be indicated. Any change in the number of steering gear motors used or in BWC should be clearly demarcated. Waypoints should be clearly marked.

Coastal navigation involves increased traffic and therefore increased encounters with other vessels. A good lookout should be maintained by all available means and frequent verification of the presence of other traffic made by more than one system. OOWs should never use one system exclusively. Interaction between the lookout and OOW is essential. The lookout (rating) should be encouraged to view the radar and ECDIS occasionally to be aware of approaching targets. Once these are sighted, this will provide the OOW with a good estimation of visibility.

Appropriate avoidance measures must be taken when approaching vessels pose a risk of collision. There will be points on the passage where increased crossing traffic and incidence of recreational craft may be expected. Fishing vessels can be encountered anywhere and everywhere. Their movements are often erratic and unpredictable and they are best given a wide berth where possible.

This increased activity makes it essential to maintain good situational awareness. This can be enhanced by sharing thoughts by, for instance, telling the duty lookout about intended manoeuvres or asking about the location of deck crew. At least once every watch, cross-check equipment; for instance, determine gyro and compass errors and engage and check hand steering.

Continuous position monitoring techniques should be adopted by two independent means whenever possible for example, using differential GPS and parallel indexing or radar ranges. Occasional position sensor verification fixes should also be taken at appropriate times, such as when a light is abeam. This will confirm the accuracy of the GPS-derived position. Another check is to use the radar overlay on ECDIS.

REMEMBER
Never use just a single system for position and traffic monitoring.

Company checklists should be followed to ensure no activities are overlooked. A key task is determining the compass error. Alarm management is essential for effective bridge watchkeeping and it is very important during coastal navigation to avoid distracting the OOW unnecessarily. Values of alarms must be carefully considered at the passage planning stage. Records of navigation activities should be made in the deck logbook and communications recorded in the GMDSS logbook throughout.

The ocean passage

As the ship leaves the coast and moves into deeper water for the ocean passage the margins of safety increase. The frequency of fixing the position of the ship can be reduced. The ship will move away from the TSS and the traffic volume will decrease. Deeper water will also mean fewer fishing vessels and there will be more room to avoid those that are encountered. All this translates into less collision avoidance work, although a good lookout is still needed and situational awareness must still be maintained.

Maintaining a lookout when there are no ships and no coastal features can be boring, and for this reason there needs to be extra effort to ensure it is not neglected. On ships of older design, the OOW could walk around the bridge constantly scanning the sea surface to maintain attention. With ECDIS and the centralisation of alarms this may not be possible as it would take the OOW away from the alarms, although brief checks on each bridge wing may still be carried out.

Ships will be exposed to the full effects of weather and there must be close monitoring of both weather forecasts and the weather conditions experienced by the ship. Weather reports will now be received via the Safety Net system and the reception for NAVTEX messages will eventually fade away. Some companies subscribe to weather forecasting tools from accredited providers. Note that official weather reports are those received from GMDSS.

During daylight hours only, and in accordance with the rules, the OOW may be the sole lookout, provided they can dedicate their full attention to this function. This will usually be announced in the Master's Order Book the night before, when permission is given for this to start on the morning watch at sunrise. If the Master issues daytime orders, they may also confirm this for the rest of the day.

REMEMBER
It is important for the OOW to know where the crew are working and what they are doing so their safety is not compromised by the OOW's actions.

Position-fixing will continue, with GPS as the prime source. The only alternative electronic position-fixing systems are inertial navigation systems, but few ships are fitted with them as they are very expensive. DR positions can be plotted in advance (predicted) so that any difference between the observed (GPS) position and DR can be investigated.

The alternative to GPS for observed positions in deep sea is celestial navigation. Star sights may be taken at twilight in the morning and evening, and observation of the sun can be made in the morning and at noon – in total, just three positions a day.

ECDIS will always be updating the position of the ship according to set and drift experienced. If the GPS should fail, it will switch to DR mode and the resultant EP shown will be very close. However, celestial navigation is a skill that any navigating officer should practise so that it can be used to determine the ship's position if needed. With sight reduction methods and relatively cheap celestial navigation software, the hard work has been taken out of calculating the ship's position. See *The Admiralty Manual of Navigation Vol 2: Astro Navigation* published by The Nautical Institute.

Routine checks of navigation equipment should be undertaken in accordance with the company checklist each watch: daily, weekly and monthly. Fire and safety rounds should also be completed at the end of every watch during the hours of darkness.

The end of the ocean passage comes when the ship crosses the 200m contour, reaches the continental shelf or comes within 50 miles of the coastline. This approach may be parallel, as when moving along the Mexican coast after crossing the Pacific using the Great Circle track, or perpendicular as after crossing the Atlantic on a voyage from the Strait of Gibraltar to Savannah.

It is important to confirm the vessel's position using an alternative method from GPS using radar or visual bearings. Occasionally long-range lights will assist in this. A single range or bearing alone may be the initial landfall indication needed and, as the ship gets closer and coastal features become more distinctive, a good fix will become possible. Remember that crossing a recognisable depth contour (200m or 100m) will serve as another position line.

Pilotage inwards

As the ship approaches port, a pilot will usually embark or, if the pilotage is long, several pilots (sea, river and docking) may embark. Before embarking the pilot, a series of pre-arrival tests must be conducted to verify that machinery and equipment is functioning correctly.

It is good practice to hold a bridge team briefing before arrival so that all members are aware of the plan for arrival and berthing. Many ships now ensure that the latest updates to ENCs are obtained before port entry. Local Notices to Mariners should be consulted. It is possible that not all information will be available at this meeting and any missing information should be highlighted in advance on the MPEX and obtained from the pilot. Key equipment tests will include the steering and control of the main engines; some countries, for example the USA, require these tests by law. Quote the CFR number.

When approaching the pilot boarding location, the pilot station should be contacted via VHF and the ETA confirmed. The side for boarding should be confirmed, although occasionally the pilot will simply say the lee side and leave the decision to the ship. Other information required is the height of the bottom rung above the water. On ships with high freeboards, the gangway must be used in combination with the pilot ladder. Contingency plans should be in place in case the berth is not available or if pilotage or river and channel movements are suspended due to poor weather or restricted visibility.

Too many pilots have died and too many have been seriously injured due to defective, non-compliant or improperly rigged pilot ladders. The correct preparation is essential and is stipulated in SOLAS Chapter V Regulation 23. Most ships have a poster from IMPA entitled Required Boarding Arrangements for Pilot, which is in accordance with SOLAS V/23 and IMO Resolution A.1045(27). This poster can be found here: https://www.impahq.org/admin/resources/finalimpapladderposter.pdf

Once prepared, and before use, pilot boarding arrangements should be checked by a qualified officer and recorded in the deck logbook. As best practice, pilot ladders should be stencilled with the length measured from the bottom at frequent intervals so that the correct length may be deployed.

As the pilot boat approaches the ship, an officer should be waiting at the pilot ladder with enough crew members to adjust the height of the pilot ladder or gangway when used in combination. Proper lighting should be available; care should be taken to avoid it shining into the face of the pilot boat coxswain. A heaving line should be prepared to take the pilot's bag.

These reports should be made to the bridge by the officer standing by the ladder:

- Pilot boat alongside
- Pilot on the ladder
- Pilot on board
- Pilot boat clear.

These are necessary because the ship and pilot boat will be making way during pilot transfer. If there is a problem, such as the pilot falling in the water or the pilot boat encountering problems, the engine may need to be stopped immediately or the helm put hard over.

Someone must accompany the pilot from the ladder to the bridge. That person needs to have a handheld VHF to report progress towards the bridge. If outside steps are used to access the bridge, remember to ensure there are no anti-piracy devices or security obstacles such as locked doors.

Once on the bridge, the pilot will need to remove their lifejacket, wet weather clothing, bag, coat and helmet. The MPEX should now take place. At this time the OOW should have the con to allow the MPEX to proceed. A copy of the pilot card should be provided to the pilot. Once key arrival details have been completed, the con transfers from the OOW to the pilot.

REMEMBER
Offer the pilot something to drink and inform them of meal times and the food available.

Remember to announce key moments in a loud voice:

Master – *Master/pilot exchange completed.*

All bridge team – *Master/pilot exchange completed.*

OOW – *The pilot has the con.*

Pilot – *I have the con.*

Bridge team – *The pilot has the con.*

These exchanges will be recorded on the VDR. If detailed discussions during the MPEX and the change of con confirmation are also made close to the VDR microphone, all will be recorded.

The time needed for this exchange can be reduced if most of the information for the MPEX is exchanged before the pilot arrives on board. Ships could send their static information in advance and pilot services could send the waypoints for the inbound passage to the ship. This gives the navigator the opportunity to enter them into the ECDIS.

During the inbound passage, the bridge team should give all their reports and confirmation of orders to the pilot. Positive or closed-loop reporting should be used throughout. The OOW should monitor the pilot's orders, such as those for the helm and the course, to ensure these are being implemented correctly.

X-REF

For more on closed-loop reporting, see pages 37-38.

The OOW executes the pilotage plan and ensures the vessel keeps to the track, notifying the pilot of any deviation (XTE) to port or starboard should it occur. They will also call out distances to the waypoints and advise of UKC. If at any time the OOW is unsure of the pilot's intentions, they should not hesitate to ask the pilot. This could be phrased simply (first example) or more formally (second example):

OOW – *Are we going to slow down for this outbound ship, Pilot?*

OOW – *Verification of intentions, Pilot: will you slow down for this outbound ship?*

The OOW should respond to the pilot's requests for information, which may include distances from ships and speed over the ground.

During the whole pilotage phase the OOW will record navigation information, including the preparation phase. This will include information such as: main engine tested astern, steering gear tested according to checklist number 99, details and times of pilot embarkation (including pilot's name), passing key points in the channels and any change of pilots. As the ship starts to manoeuvre off the berth more recordings should be made, which include the details of any tugs being used and manoeuvres such as the vessel turning short around to starboard assisted by tugs. Then the time the vessel comes alongside with which side should be recorded. Finally, the number of mooring ropes deployed should be recorded. A sample record might say:

Forward springs posted, forward headlines posted (2 + 1) fast fwd. mooring lines posted.

All fast F & A 4 + 2 + 2 (four headlines, 2 breast lines and 2 springs).

Many of these details and times will be recorded in ECDIS. Key events can be recorded by pushing the event mark control and adding text to the movement book.

Anchoring

Anchoring may be planned, a planned contingency, an unplanned emergency or accidental. An anchorage may be planned if the ship is advised in advance that it will have to go to an anchorage for several days until a berth becomes available or when operations at anchor are planned (an anchor berth).

A contingency may be planned in case the ship needs to anchor if, for instance, passage to the berth is blocked by another ship or if the ship needs to carry out operations such as reducing draught.

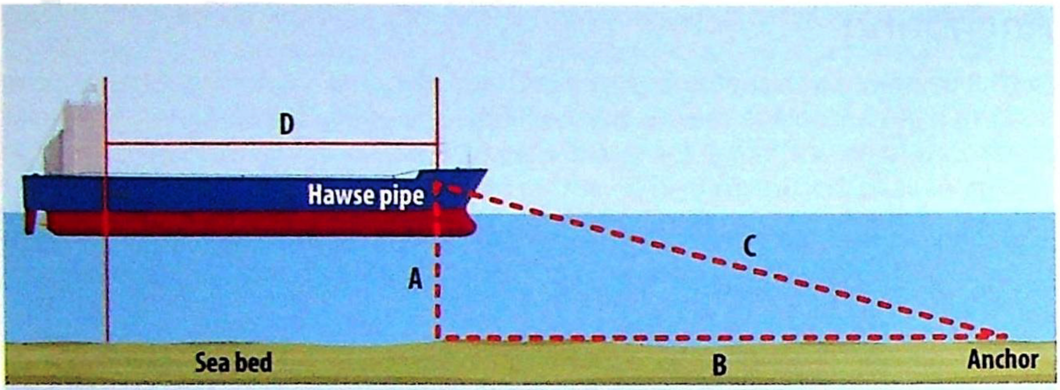
An unplanned emergency can occur when an unforeseen event makes further progress dangerous and the ship must anchor as soon as possible; for example, if there has been a collision ahead of own vessel.

An accidental anchorage may be needed if the ship drops anchor or anchors while underway if control of the vessel's steering and/or propulsion has been lost.

To be able to anchor a ship, the anchors must be free to run out by removing seagoing lashings such as chains and or wires. Brakes must be hardened up and the bow stoppers (guillotine or screws) removed. These actions must be carried out before the ship arrives at the anchorage and it is good practice that anchors are available from the pilot boarding area inwards, or *vice versa*.

For planned anchoring, the anchor to be used should be discussed at the pre-arrival meeting. The anticipated weather for the duration of the anchorage should be taken into account. All anchorages should be checked to ensure they are clear of all obstructions such as cables and pipelines, rocky ground or foul areas. The depth of water at the anchorage positions should be calculated and the amount of cable to be used determined. Decide whether the cable will be walked back to the seabed or dropped from the pipe. This will depend on various conditions at the anchorage. In the northern hemisphere the port anchor is mainly used, as depressions approach from the west. The wind therefore backs – it changes direction in an anti-clockwise direction. If the ship has to drop a second anchor, in theory it will not foul the first.

The role of the OOW will be to activate these preparations for anchoring as the ship approaches the anchorage. The OOW should be prepared in advance to fix the ship's position when the anchor is let go to allow the position of the anchor to be fixed and when constructing the swinging circle. The relevant function can be used on ECDIS for this.



To be able to construct the swinging circle of the ship, we need to calculate the radius of the circle. This will be the sum of D + B; where D is the distance from the bridge wing to the bow and B is the distance from the anchor to the hawse pipe

In the diagram, side C of the triangle is the amount of anchor cable deployed;
side A equals the depth of water plus the height of the hawse pipe above sea level
From Pythagoras theorem Side B therefore = $2\sqrt{(C2 - A2)}$

The radius of the swinging circle is D + B
Let us assume the ship has dropped 6 shackles of cable = 6 x 27.5 metres = 165 metres
The depth of water = 27 metres and the hawse pipe is 13 metres above the water: A = 40 metres

So B = (165 x 165) + (40 x 40) = 27225 + 1600 = 28825

$2\sqrt{28825}$ = 169.8, say 170 metres

If D = 155 metres, then distance of the bridge to the anchor = D + B = 155 + 170 = 325 metres

The swinging circle is therefore centred on the anchor position with a radius of 325 metres.

Calculating and constructing the anchor swinging circle

Record in the movement book when the anchor is let go and the amount of cable paid out. When the order to hold on is given, the heading of the ship should be noted and, once the cable is tight, the position fixed. This will show the extreme of the swinging circle. The anchor shape and anchor lights should be displayed and the AIS status updated. Once the Master is satisfied, they will advise of the notice to be given to the ER to prepare the main engine in case of need.

Where possible, anchor bearings of terrestrial objects should be taken and used to fix the ship's position at anchor. Provided these positions remain within the swinging circle, the ship will not have dragged anchor. These may be supplemented by the anchoring function on the ECDIS, EBL and VRM on the radar, the GPS anchor alarm and the echosounder alarm.

The anchor watch will regularly verify the ship's position to ensure the ship does not drag the anchor; monitor approaching vessels, especially those that anchor close by; and keep watch on the VHF channel as advised by port control.

Arrival at the berth

Arriving at the berth which may be a dock, a wharf, a jetty or a pier usually reduces the horizontal margin of safety to zero once the ship's hull touches the fenders. When a ship enters drydock the vertical margin of safety (UKC) will also reduce to zero as the ship touches the blocks. These are delicate manoeuvres and require careful use of rudder, engines and tugs to avoid damaging the ship's hull. Large ships have a Doppler log that shows athwartships (sideways) speed. Pilots use this information to ensure gentle landings on fenders. Many smaller ships are now being provided with this equipment.

Before arrival off the dock, the pilot will explain the expected manoeuvre to the bridge team and indicate where tugs will be positioned. Some ships do not use tugs, some just use the bow thruster, and others may use up to six tugs depending on the size of the vessel. The OOW should show where the tugs are used and whether they are made fast, pulling, pushing or just standing by. The OOW should check the bollard pull of the tugs being used with the pilot and tell them the safe working load (SWL) of the bitts.

The OOW's main duty will then be to monitor and execute the pilot's orders and record events. Position-fixing will be reduced to a minimum interval and collision avoidance to almost nil. Monitoring UKC becomes a high priority.

Many ships have bridge wing controls and, as the ship approaches the berth, the pilot and Master will move to the bridge wing. Transfer of command of controls will be made from the wheelhouse to the bridge wing. When this is done, take care that the control has indeed transferred to the other position. Some ships have telegraph, steering and thruster controls located on the bridge wings. Once command is transferred, and as the ship comes alongside, the Master may dismiss the helmsman and lookout and send them to attend the gangway.

Mooring will now start, and it is good practice to send spring lines first, unless there are strong currents at the berth. In that case pilots will stem the current (head into) so that they will always have the main engine (ME) to hold the vessel until all lines are fast. Headlines and stern lines will follow, and then the breast lines. Record when 2+1 are fast forward and aft. Finally, all ropes are deployed; when all fast, this is recorded:

All fast F&A 4 + 2 + 2.

The Master will indicate when to notify the engine room the time of finished with engines (FWE). Navigation lights should be switched off and the AIS updated. Any required communications should be made with the port control.

Closing down the bridge after arrival

To ensure the safety of the ship when it is alongside, it is essential that bridge equipment is turned off or left in standby mode. There will be different priorities depending on the ship type: for tankers it will be the prevention of explosions by limiting ignition sources, for passenger ships it will be the condition of watertight doors – whether open or closed – and, on all ship types, this should work to prevent injury through the inadvertent operation of rudder, propeller or transverse thrusters.

Steering gear

For many years both motors were turned off once the ship was alongside in port. Recently however, some manufacturers recommend that one motor should be left running to prevent hydraulic lock. Steering gear control systems should be turned off where this is possible.

Bridge control system

This should be switched to ECR.

Transverse thrusters

These should be turned off and ventilators closed.

Radar

Turn off in case personnel find their way to the monkey island when they would be close to the scanners. On container ships, radar should be turned off to prevent harm to gantry crane drivers. On tankers, it is sometimes a terminal requirement that they be turned off for fire safety.

In all cases, terminal regulations must be observed.

VHF

These are a potential source of ignition and therefore on tankers should be switched to low power – 1 Watt.

AIS

This is another potential ignition source and should also be left on low power. However, if the set is polled by another AIS it may automatically revert to full power. In such cases the aerial should be disconnected.

Echosounder recorder

This should be turned off unless critical draughts are to be experienced alongside. Then it should be left on and the UKC alarm set to the in-port value. If this alarm set point is reached, the echosounder alarm will trigger the BNWAS. The bridge navigation watch alarm system should be turned off if in manual mode.

Shell doors

Check that those that were opened on the outboard side for pilot embarkation are now closed. Ships with shell doors for mooring operations may have these open during port stays. A status board should be available on the bridge to show which are open and which are closed and these should be reported during safety rounds. ISPS regulations must be in place and adhered to.

Deck lighting

This should be turned on and any surveillance equipment made operational. Once the gangway has been rigged and checked, an entry should be made in the deck log.

Chapter 7

Future developments

It is satisfying to see the change in trends towards making navigation safer. Many shipowners are now prepared to invest in new technology. Even in the smallest cafés, serving staff have devices to take your order and transmit it to the bar or the kitchen to prepare your food and drink. It is about time that kind of technology was brought to the bridge.

Position-fixing has been greatly improved by ECDIS and it is possible to do everything that was done before, albeit in a different way. Combining this with ARPA information makes it possible to have at least two continuous position-fixing systems. In this context, I foresee an ability to take visual bearings from the conning chairs in a way that is perhaps similar to a submarine's periscope. If we can have reversing cameras on cars, surely we can have bridge wing cameras on ships with a Doppler log overlay? These will greatly help with the docking of large ships.

I am concerned about the console becoming ever longer. We have done away with the chart room and removed the need to go backwards and forwards on the bridge, losing situational awareness at night as we do so. The controls and instrumentation are now a long walk away from the conning position.

If wheelhouses were smaller, a much larger angle of view would be available to the bridge team. Instrumentation could be duplicated, as on an aircraft with the same displays on each side. Bridges of this type already exist on high-speed craft. An additional monitor could be provided for GMDSS information to remove the need to move to the GMDSS station. SOLAS already anticipates electronic logbooks and ECDIS maintains so much more information than could be recorded by hand in hard-copy logbooks. These developments could be complemented by both external and internal cameras.

ECDIS could be developed to include a symbol for action points for when officers are required to DO something such as slow down, turn on an extra steering motor, increase the bridge watch condition or call the Master. When reaching these points, the ECDIS would sound an alert for the OOW. These would be tabulated and could be edited, amended or deleted at the planning stage.

Perhaps we will see some serious advances in radar in the future, as the basic spec has hardly changed in years. Imagine a position sensor from radar that gives the latitude and longitude of own ship from a known radar target, such as a Racon.

Thinking even further into the future, we may get to the point where pilotage authorities provide the ship with the inbound passage plan in advance of arrival to allow the navigator to programme this into ECDIS. Or a pilot information overlay could be provided over NAVTEX.

It is time to see the CO on the bridge with the Master for port arrivals and departures. Then they could take turns in conning the ship in the same way that many aircraft crews already do.

The regulators have some serious work to do as well. They could start by defining exactly where the conning position is on a modern bridge and bringing rules up to date to reflect this.

Decision support systems will increase in usage, but fully autonomous systems will take many years to be incorporated into marine transport systems. The problem lies in algorithms and trust. Ask any UK university entrance level student who took their examinations in the pandemic summer of 2020 if they trust algorithms and the answer will be a resounding no. It is up to the designers of such systems to win the trust of the marine industry and not the other way around. At present their record is poor.

It is pleasing to note that many nations have now officially recognised that seafarers are essential, strategic or key workers, according to their terminology. How many of them have considered adding this category to the observation page on seafarers' passports? Imagine the entry: Seafarer – strategic worker – IMO# 1 44 1234567. This future would see IMO establishing a register with, for example, the code 1 for a person, 44 as country code, followed by the seafarer's number. Would it be so difficult or am I dreaming?

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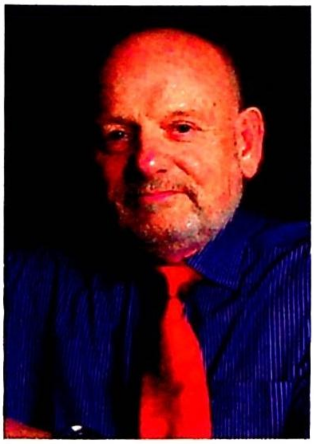


Captain Mark Bull FNI

Mark started his seagoing career in 1970 with P&OSN Co Ltd and obtained his Master's Certificate in 1982. He was promoted to Master in 1992. His sea service spanned 27 years serving with P&O, United Arab Shipping Company, Harrison Line, Lion Shipping and Gibline and Columbia Shipmanagement (CSM). He sailed on numerous ship types – general cargo, passenger, chemical tanker, heavylift, reefer, reefer container, fully cellular container and a high-speed catamaran. His rescue of 15 people from a superyacht in the Strait of Florida during his last five years in command earned him a commendation from the US Coast Guard.

He took a two-year sabbatical in 1988 where he trained, qualified and practised as a teacher of English as a second language (TEFL). Then in 1997 Mark decided to train as an ISM/ISO auditor and once qualified was brought ashore. His first task was to put the entire CSM fleet through the ISM audit. In 1998 he undertook his first navigation audit, which he went on to develop for the fleet as a support system for newly promoted Masters.

Serving as marine manager then Quality Manager and DPA he developed a command promotion scheme, updated company procedures and established a fleet-wide security system to satisfy ISPS Code requirements, liaising with various flag states.

He moved to an International Group P&I club as Loss Prevention Manager and later helped set up a German ship management company. In 2012 he established his marine consultancy and since 2015 has been exclusively involved in navigation assessments.

Mark is a Fellow of The Nautical Institute, a member of its Council and its Technical Committee. He has held the position of Honorary Secretary and Chairman of the Institute's Southern Iberian and Cyprus branches and is currently Honorary Secretary of the Iberian Branch. He was a contributor to the NI's publication *Navigation Assessments*, and established the Navigation Assessor training course, which he has delivered in numerous cities around the world.

Peer reviewers and editorial board

Captain Sajith Babu AFNI

Captain Sajith is a Master with Singapore-based ship management company Suntech Ship Management Pte Ltd. Taking command of tankers has given him a passion for improving safety and developing practical quality systems on board ships.

He is a mentor, encouraging the development of a safety culture in the minds of young seafarers and inspiring them to achieve. His passion for technology and its practical application on board has motivated him to pursue research work in this area.

He serves on The Nautical Institute's Younger Members' Council, is a member of the Company of Master Mariners of India (CMMI) and has completed a Post Graduate Diploma in Shipping Management from NMIS, India.

Paul Chapman FNI

Paul started a cadetship with the Australian National Line in 1979. After gaining experience of a variety of ships and trades including command with Jardine Ship Management, he came ashore in 1991. Paul was appointed a pilot by the Marine Board of Queensland in 1992. Starting in Mackay and Hay Point he moved to the Port of Gladstone in 1994, where he continues to pilot.

Paul has a keen interest in practices and designs that enhance situational awareness in confined waters, especially with radar. Magnetic compass design and correction is also a strong passion. These interests have been shared through articles in The Nautical Institute's journal, *Seaways*. He is the author of The Nautical Institute monograph *Monitoring Turns Using Radar.*

Colin Dewey PhD AFNI

Colin began his career in the US Coast Guard, continuing to tankers, container ships and offshore tugboats. He holds limited Master and mate's licences, serving as mate and Master on the San Francisco Bar Pilots' ocean and inland vessels. He now teaches literature, maritime history and maritime studies at the California State University Maritime Academy. His 2011 doctoral dissertation from Cornell University was called 'In Deep Water: The Oceanic in the British Imaginary, 1666-1805'; a chapter on technological and regulatory developments in the 20th century called 'Practices in A Cultural History of the Sea' is due for publication in 2021. He is preparing another: *Lyric Circulation: Logistics, Globalization, and the Poetics of Oceanic Romanticism*. He is Honorary Secretary of the US West Coast Branch of The Nautical Institute.

Captain Konstantinos D Geomelos MSc PgDp AFNI

Captain Geomelos started his seagoing career as a cadet with Chandris (Hellas) Inc in 1991 and obtained his Master's foreign-going certificate in 2006, serving on bulk carriers and tankers. He now works ashore with Chandris as Navigation Manager – Marine Superintendent.

As well as his time at sea he is experienced in ship management, sailing, internal audits, navigation assessments, VDR data analysis, tanker operations, shipbuilding and drydocking, mentoring, training and motivation of crew and marine safety.

His Master's degree focused on shipping business administration and management and his diploma degree from the University of Plymouth concentrated on international shipping and logistics management. He is an Associate Fellow of The Nautical Institute and a member of various Greek Maritime Agency committees.

Álvaro Jiménez Gómez

Álvaro, from Spain, serves as an unlimited Chief Officer, currently working at Royal Caribbean International as a Second Officer.

He started his career in cargo ships, mainly in ro-ro and ro-pax vessels, with the goal of working in the cruise industry, achieving his ambition in 2018.

Captain Ivo Jutrovic MSc AFNI

After graduating from nautical school and the navy academy Ivo served on cargo ships, taking his first command on container/multipurpose ships engaged in worldwide trade. For the past 13 years he has served as a Master on container ships, including ultra large container ships. HIs contribution to the book has been from that practical experience standpoint.

He has also served as a navigation officer on the Croatian Navy sail training ship and in the Croatian Hydrographic Institute's Nautical Department. He has been a member of The Nautical Institute since 2006.

Deirdre Lane FNI MSc Master Mariner

Deirdre holds an MSc in Shipping Operations along with a BSc in Nautical Science and a Diploma in Port Management.

Deirdre was appointed Harbour Master in 2018. She serves on The Nautical Institute Council and is vice-chair of its Technical Committee.

Colin Pratt FNI

He first went to sea with P&O, serving on LPG vessels, taking command in 1991 after the gas fleet was transferred to Norwegian ownership. He then transferred to Tees Bay Pilots in 1996 and has served there ever since, reaching Senior First Class Pilot in August 2001.

His interest in pilot safety led to the founding of Longscar Marine Consultants and Colin's involvement in the delivery of BRM for pilots and the development of port-specific passage planning applications.

He is actively involved in The Nautical Institute's North East Branch, is a member of the Institute's Technical Committee, the Marine Society and Sea Cadets and is a Younger Brother at Trinity House, London.

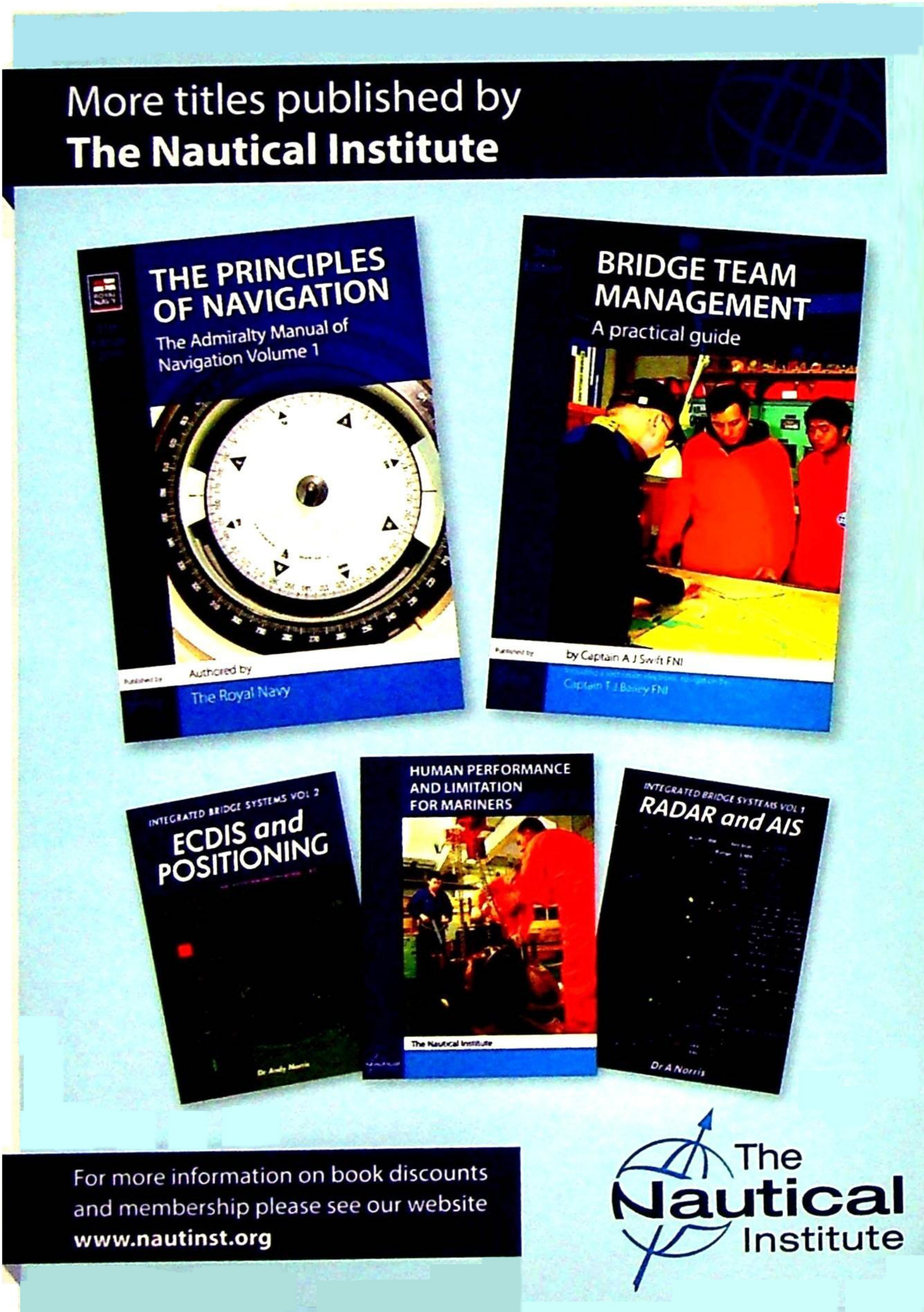
Laura Pinasco AFNI

Laura started as a deck cadet in 1997 and gained her first command in 2008, serving on a variety of vessels, mostly gas tankers. Coming ashore in 2011 she served as a Tug Master in Genoa, moving to vetting inspector, navigator assessor and marine consultant from 2018. She recently took the command of a cargo vessel.

Verena Stiller

Verena became a seafarer after graduating from business and law school first gaining experience on board a traditional sailing ship before transferring to Aida Cruises. This sparked an interest in the whole ship's construction and operation, prompting a move to study at the Hochschule Wismar in 2018 – the University of Applied Science, Technology, Business and Design at the Department of Maritime Studies, Systems Engineering and Logistics.

During her studies, she sailed on cargo ships as deck cadet and completed basic training for all types of tanker vessels and the STCW courses for advanced firefighting and survival craft and rescue boat operations. She expects to finish her studies in 2021.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Third edition

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Captain Peter Boyle MA CMMar FNI

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