LIETUVOS AUKŠTOJI JŪREIVYSTĖS MOKYKLA
LITHUANIAN MARITIME ACADEMY

Liepājas Jūrniecības koledža

LEARNING MATERIALS FOR NAVIGATION AND MANOEUVRING ACTION IN LABORATORY

Liepaja Marine College
Lithuanian Maritime Academy

LEARNING MATERIALS FOR NAVIGATION AND MANOEUVRING ACTION IN LABORATORY

Learning Material

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The duties of Ship Masters and Navigation Officers is increasingly supported by electronic means and significantly computerized. Therefore, the use of radio-electronic system of communication and electronic charts and adaptation of computer skills to safe navigation and manoeuvring are capabilities that not only need to be continuously developed as skills, but also as a base for teaching and methodologies to be dealt with in an interconnected system, or in modern language, integrated.
In this book, students are offered a study material that not only provides modularly focused information and guidance on the use of GMDSS and ECDIS, but also points to the integrated role of these systems in organizing and managing the bridge resources. The maximum realization of these processes is achievable through modern simulation capabilities, which is also the essence of this book. Notwithstanding the above stated, the book is more specifically designed for practical/laboratory tasks, therefore, students working with this material, should also have a fundamental knowledge of these systems and resources on board of a vessel.

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LLI-42 LatLitNaviPort Improvement of the workforce mobility and skills in Latvian-Lithuanian Maritime Transport Sector

Two educational institutions, Liepaja Marine College (LMC)and Lithuanian Maritime Academy (LMA), have joined their efforts to solve human resource problem. Both institutions provide higher education and trainings in maritime transport sector, and are located in cities of Liepaja and Klaipeda having sea ports and direct territorial demand for qualified maritime transport sector specialists.

The main objective of the project is to improve the competitiveness of seafarers and logistic specialists in ports by improving education quality.

With the support of European Regional Development Fund (ERDF) within the framework of LatLitNaviPort project of the Interreg V-A Latvia-Lithuania Cross Border Cooperation Programme 2014–2020, project partners from Latvia and Lithuania aimed to increase the scientific and educational capacity. The project will have the following outputs: subjects in training programmes will be updated, new short training course for logistic port operation specialist will be developed in LMC, and modern training facilities – Navigation, Manoeuvring and Engine Control Laboratory – will be installed in LMC and Port operation simulator in LMA. Teaching staff of both institutions will upgrade their qualification by participating in 3 training courses, exchange experience, create 5 learning materials for joint use (Latvian-English and Lithuanian-English versions). Two joint pilot group trainings will be organized. One joint simulation trial will be held.

The project common territorial challenge is to fulfil the demand to reduce workforce mismatch and increase the number of people receiving upgraded skills matching labour market, increase mobility and employability in territory of Latvia and Lithuania.

In general, the planned activities of the project will give a significant contribution to economic development in Kurzeme region and Lithuania. Both project partners will be able to provide quality education matching labour market needs, thus making it possible to reach the goal of INTERREG Programme 2014–2020 to enhance sustainable socioeconomic development of the participating regions by raising their competitiveness and making them more attractive for living, entrepreneurship and tourism. Total project size is 900 286.38 EUR of which 765 243.42 EUR is the co-funding from the European Regional Development Fund.

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CONTENTS

PART 1

GMDSS – GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM

ANATOLIJS DOMIŅUKS

INTRODUCTION

This Compendium to the IMO Model Course for the GMDSS GOC is intended as an aid for both students and instructors who apply for GMDSS GOC Certificate. It aims to bring together into one document theory concerning different aspects of radio communications, which may be of value in explaining and comprehension of subjects studied for the GOC.

The training should be relevant to the provisions of the STCW Convention, the Radio.

Regulations and the SOLAS Convention currently in force give particular attention to provisions for the global maritime distress and safety system (GMDSS).

When using the compendium, it should be noted that the students are training to become operators of radio communication equipment, and not technicians or engineers. Students may find the theoretical and general parts helpful for background reading, which will increase and clarify their understanding of the subjects. Knowledge of use, operation and service areas of GMDSS sub-systems, including satellite system characteristics, navigational and meteorological warning systems and selection of appropriate communication circuits will be useful for the students of Marine Academy and colleges.

Global Maritime Distress and Safety System (GMDSS) is an international system, which uses improved terrestrial and satellite technology and ship-board radio systems. It ensures rapid alerting of shore-based rescue and communications authorities in the event of an emergency. In addition, the system alerts vessels in the immediate vicinity and provides improved means of locating survivors. Moreover, this system provides Maritime Safety Information Broadcast between all participants.

GMDSS was developed through the International Maritime Organization (IMO), and represents a significant change in the way maritime safety communications are conducted. While it is mandatory for all ships subject to the International Convention for the Safety of Life at Sea (SOLAS) (cargo ships of 300 gross tonnage or greater and all passenger vessels on international voyages), GMDSS will have impact on all radio-equipped vessels, regardless of size. The global implementation of GMDSS services became effective on 1 February 1999.

In order to be properly understood and operated by staff of ships, training will be required for those whose responsibilities include the GMDSS communications in accordance with the 1995 amendments to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW), namely for all Navigational Officers.

1.1. HISTORY

From the end of the 19th century, for distress and safety telecommunications ships at sea have relied on Morse code, invented by Samuel Morse and first used in 1844. After the sinking of RMS Titanic in 1912, the need for ship and coast radio stations to have and use radiotelegraph equipment was recognized. The United States Congress responded shortly after, requiring the US ships to use Morse code for distress signals. The International Telecommunications Union (ITU) followed suit for ships of all nations. Thousands of lives were saved using Morse encoded distress calling, but there were certain limitations in use.

A. Its range on the medium frequency (MF) is limited to 150 nautical miles.
B. Morse signals are very limited in amount of traffic.
C. Skilled radio operators are needed for continuous listening of radio distress frequency.

For the reasons mentioned above, the IMO (International Maritime Organization, a United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships) began looking at ways of improving maritime distress and safety communications. In 1979, International Convention on Maritime Search and Rescue was drafted by a group of experts, which called for the development of a global search and rescue plan. This group also passed a resolution calling for the development by IMO of a Global Maritime Distress and Safety System (GMDSS) to provide the communication support needed to implement the search and rescue plan.

This new system, implemented by the world's maritime nations, is based upon a combination of terrestrial and satellite radio services and has changed distress communications from being ship-to-ship to ship-to-shore. The Morse code era of communications was ended. Apart from automatic distress alerting and locating services, GMDSS requires ships to receive MSI (Maritime Safety Information) broadcasts, which could prevent a distress from happening in the first place. In 1988, IMO amended the Safety of Life at Sea (SOLAS) Convention, requiring ships subject to it fit GMDSS equipment. Such ships were required to carry NAVTEX and satellite EPIRBs by 1 August 1993, and had to fit all other GMDSS equipment by 1 February 1999.

1.2. GMDSS EQUIPMENT

1.2.1. Emergency position-indicating radio beacon (EPIRB)

GMDSS makes use of the COSPAS-SARSAT Satellite System, which provides global detection of 406 Megahertz (MHz) EPIRBs. COSPAS-SARSAT is an international satellite-based search and rescue system, established by Canada, France, the United States, and Russia. These beacons are small, portable, buoyant, and provide effective means of issuing a distress alert anywhere in the world. These automatic-activating EPIRBs are required on SOLAS ships, commercial fishing vessels and all passenger ships. EPIRBs are designed to transmit alert signals to rescue coordination centres via the satellite system from anywhere in the world. It is planned to add further enhancements for the use of medium earth orbit satellites provided by the USA GPS satellites and the GLONASS satellites of the Russian Federation.

The original COSPAS / SARSAT system used 4 polar low orbiting satellites (LEOSAR) and in recent years the system has been expanded to include 5 geostationary satellites (GEOSAR). The original COSPAS / SARSAT satellites could calculate EPIRB position to about 3 nautical miles (5–7 km) by using Doppler techniques, but latest modifications of EPIRBs incorporate GPS receivers implemented to transmit highly accurate positions (within about 20 metres) of the distress position, **but are not certified yet**. From the end of 2010, some EPIRB manufacturers were installing AIS (automatic identification system) transmitters in the beacons, **but they also are not certified yet**.

EPIRB-AIS devices are 406 MHz distress alerting devices that contain an additional AIS transmitter developed using the same AIS-SART technology, where the AIS component is used as an aid in locating that EPIRB-AIS. EPIRB-AIS devices will be displayed in the same way as an AIS-SART (IAMSAR I – 2.35 **additional device considerations).**

EPIRBs are usually checked monthly by crew and annually by shore base service and they have limited battery shelf life, between two and five years using mostly lithium-type batteries. The 406 MHz EPIRBs transmit a registration number only, which is linked to a database of information about the vessel. Once activated, the battery life on an EPIRB is minimum 48 hours. EPIRBs shall be tested by shore-based services at intervals not exceeding 12 months for all aspects of operational efficiency, with particular emphasis on frequency stability, signal strength and coding.

Note:
All ships shall carry **on board** a hard copy **of** updated **Volume III** of the International Aeronautical and Maritime Search and Rescue (**IAMSAR**) Manual (SOLAS, Regulation V/21).

1.2.2. NAVTEX

NAVTEX (Navigational Telex FEC mode, emission class J2B) is an international automated medium frequency narrow band direct-printing service for promulgation of Maritime Safety Information (MSI) to all ships, which includes:

- navigational warnings;
- weather forecasts
- weather warnings;
- search and rescue notices;
- any other information related to safety of navigation.

NAVTEX is a small, low-cost and self-contained "smart" printing radio receiver installed on the bridge, it checks each incoming message to see if it has been received during an earlier transmission, or if it is of a category of no interest to the ship's Master. The frequency of transmission of these messages is 518 kHz in English, while 490 kHz is sometimes used to broadcast in a local language. Typical range for NAVTEX coverage is about 200–400 nautical miles off shore, but this can be extended in certain conditions. There are no user fees associated with receiving NAVTEX broadcasts.

The updated edition of NAVTEX Manual, which entered into force on 1 January 2018, should be taken into consideration.

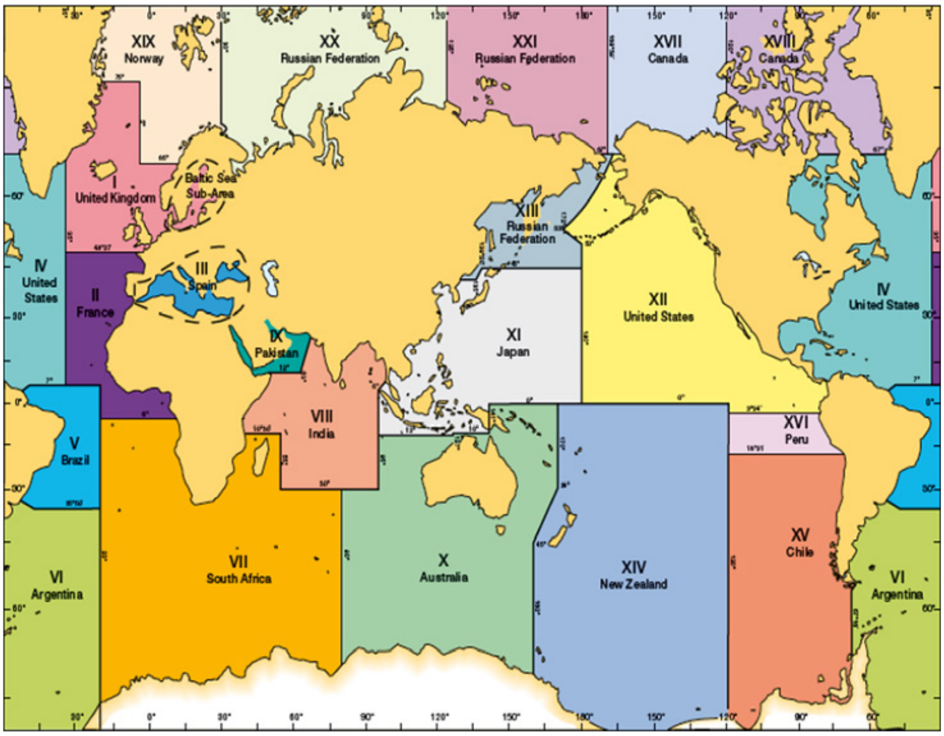

Fig. 1.1. *NAVAREAs for coordinating and promulgating navigational warnings under the World-Wide Navigational Warning Service. (9. MSC.1/Circ.1403/ Rev.1, 25 November 2016 AMENDMENTS TO THE REVISED NAVTEX MANUAL)*

"5.3.4 Reception of messages, transmitted using subject indicator characters **A, B, D and L,** which have been allocated for navigational warnings, meteorological warnings, search and rescue information, acts of piracy warnings, tsunamis and other natural phenomena, **is mandatory and cannot be deselected on the NAVTEX receiver**. This has been designed to ensure that ships using NAVTEX always receive the most essential information."

New types of NAVTEX have a connection to ECDIS with automated plotting function – each message is automatically being displayed on the ECDIS display on the related chart. In this case, NAVTEX may not have hard copy.

Apart from NAVTEX, Maritime Safety Information Broadcast can be received using Inmarsat-C terminals Enhanced Group Call – SafetyNET (EGC) broadcasts for areas outside NAVTEX coverage, and HF Narrow Band Direct Printing (NBDP) receivers can be used where service is available as an alternate to EGC. All 21 regions are shown in Fig. 1.1.

1.2.3. Inmarsat

The Inmarsat satellite network provides global communications, except for the Polar Regions. In areas without any VHF or MF DSC shore facilities, Inmarsat terminals are used for distress alerting and communications between ship and shore. Inmarsat provides an efficient means of routing distress alerts to search and rescue (SAR) authorities.

Inmarsat is a British satellite telecommunications company, offering global mobile services, which is overseen by the International Mobile Satellite Organization (IMSO). Inmarsat provides data services and telephone calls to users worldwide via portable or mobile terminals, which communicate with ground stations using twelve geostationary telecommunications satellites.

A Geostationary Earth equatorial Orbit (GEO) is a circular geosynchronous orbit 35,786 km above the Earth's equator that follows the direction of Earth's rotation.

Satellite Ocean Region is the area on the Earth's surface within which a mobile or fixed antenna can obtain line-of-sight communications with one of the four primary Inmarsat geostationary satellites. This area may also be referred to as "footprint":

- Atlantic Ocean Region – East (AOR-E);
- Atlantic Ocean Region – West (AOR-W);
- Indian Ocean Region (IOR);
- Pacific Ocean Region (POR).

There are the following types of Inmarsat terminals recognized by the GMDSS: Inmarsat C and F77 (**Fleet Broadband 500/250/150 – non-GMDSS,** https://www.inmarsat.com/about-us/safety-at-sea/).

Inmarsat F77, an updated version of the Inmarsat A, B&M (now redundant), provides the following services.

- Ship/shore, ship/ship, and shore/ship telephone.
- High-speed data services, e-mail including a distress priority telephone service to and from rescue coordination centres.
- Fleet 77 fully supports the Global Maritime Distress and Safety System (GMDSS) and includes advanced features such as emergency call prioritization.

The Inmarsat C provides the following services.

- Ship/shore, shore/ship, and ship/ship store-and-forward data and e-mail messaging.
- The capability for sending preformatted distress messages to a rescue coordination centre, and the Inmarsat C (using EGC receiver) SafetyNET service. The Inmarsat C SafetyNET service is a satellite-based worldwide maritime safety information broadcast service of high seas weather

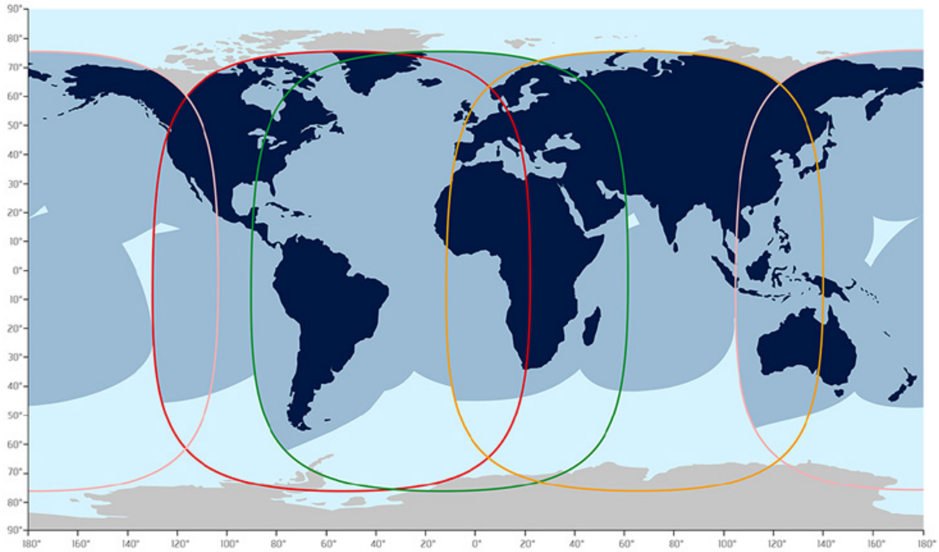

Fig. 1.2. *Satellite coverage (https://www.inmarsat.com/wp-content/uploads/2017/11/January-2017-I-3-Maritime-coverage-003.jpg)*

warnings, NAVAREA navigational warnings, radio navigation warnings, ice reports and warnings generated by the USCG-conducted International Ice Patrol, and other similar information not provided by NAVTEX. SafetyNET works similarly to NAVTEX in areas outside NAVTEX coverage.

The advantage of Inmarsat C, mini-C equipment is its small size and light weight. Inmarsat F77 ship earth stations require relatively large gyro-stabilized unidirectional antennas of bigger size and high cost, but the antenna size of Inmarsat C is much smaller and is omnidirectional.

SOLAS now requires that Inmarsat C equipment have an integral satellite navigation receiver, or be externally connected to a satellite navigation receiver. That connection will ensure accurate location information to be sent to a rescue coordination centre if a distress alert is ever transmitted.

Also, the new LRIT long range tracking systems are upgraded via Inmarsat C GMDSS, which are also compliant along with inbuilt SSAS, or ship security alert system. SSAS provides means to covertly transmit a security alert distress message to local authorities in the event of a mutiny, pirate attack, or other hostile action towards the vessel or its crew.

1.2.4. Portable VHF handheld GMDSS radio

Portable maritime VHF handheld radios can be used for the two following purposes:

- for distress communications between the mother vessel and lifesaving appliances and between lifesaving appliances;
- for on board communications between the controlling station and slave stations, and between slave stations.

Primary emergency batteries are to be stored and sealed for emergency situations and a secondary rechargeable battery must be used only for daily on board communication in the portable VHF transceiver.

1.2.5. AIS-SART

The AIS radar transmitter operates on channel AIS1 and AIS2 in the maritime mobile VHF band. The AIS SART is a self-contained radio device used to locate a survival craft or a distress vessel by sending updated position reports using a class A position report of a standard automatic identification system (AIS).

A positions and time synchronization of AIS SART are derived from a built-in GNSS receiver (e.g. GPS). Once per minute the position is sent as a series of eight identical position report messages (four on AIS1 and four on AIS2). This scheme creates a high probability that at least one of the messages is sent on the highest point of a wave. The range of AIS transmitters depends on the height of its antenna and is comparable to the range of the radiation of maritime VHF equipment.

The transmission of an AIS SART generates a special symbol on electronic sea charts (circle with cross). Figure 1.3 shows a half gated radar screen in order to point out the AIS signals (SART, vessel, base station).

SARTs incorporate the means to carry out regular tests and indicate any fault in the equipment.

Radar transponders should be tested in accordance with the producer's manual on a regular basis in the following way:

- switch SART to test mode;
- hold SART in view of radar antenna, check that the visual indicator light operates, check that audible beeper operates;
- observe radar display – there should be concentric circles.

AIS radar transmitters may be tested only by authorized persons with special test equipment on board the vessel. The producer's instructions are to be observed.

The batteries life should be checked in accordance with the appropriate label on the SART (AIS-Radar).

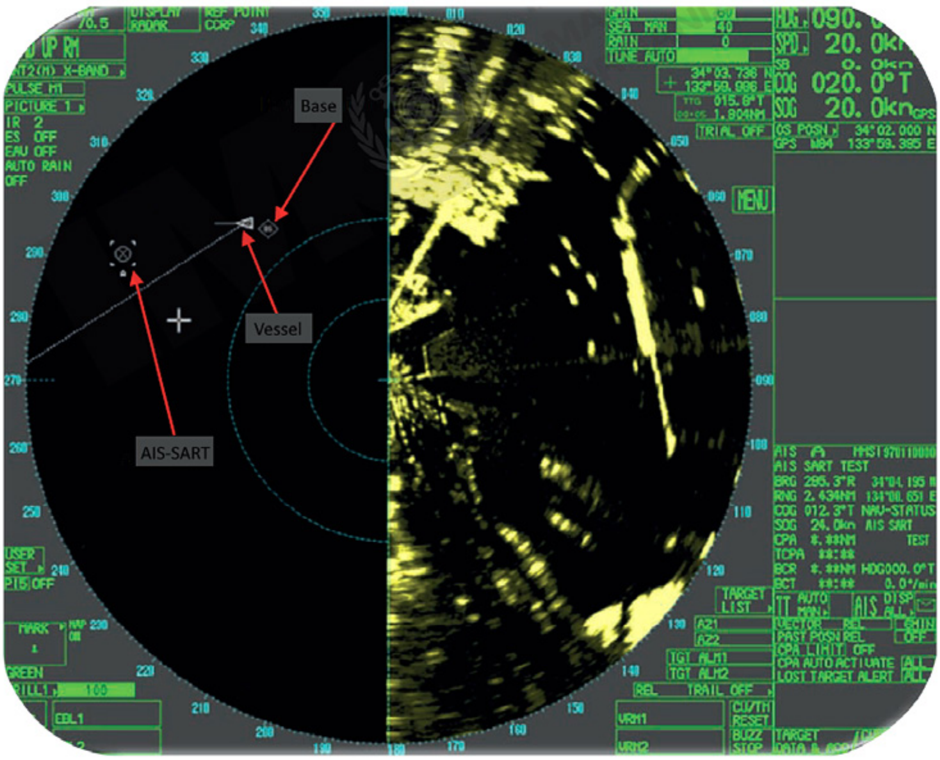

Fig. 1.3 *AIS-SART image on radar screen (5. IMO Model Course 1.25, GOC for the GMDSS. 2015 Ed. Course and Compendium).*

1.1.6. Medium/High frequency with DSC radio (MF/HF-DSC)

The range of MF transmitter depends not only on its output power, but also on an optimal matching of the transmitter to the transmitting antenna.

It depends also on the time of day. For the propagation during daylight hours the ground wave is mostly used. It is to note that a DSC transmission can generally cover a higher range than an analogue voice transmission.

On most MF transmitters the output power can be varied in several steps from low power to high power in accordance with IMO performance standards. To avoid any interference, the lowest necessary output power shall be selected for establishing contacts.

To avoid interferences, the lowest necessary output power shall be selected when installing MF/HF contacts. For establishing contacts with stations within a close distance to the transmitting station, the use of the "low power" output should be sufficient, whilst contacting stations at a greater distance, the use of the "high power" transmitting position can be selected.

Distress Urgency and Safety Information – ship to ship, ship to coast station, all stations to individual station, as well as geographic area announcements are transmitted and received on frequency 2187.5 kHz.

A GMDSS installation may include high-frequency (HF) radiotelephone and radiotelex (narrow-band direct printing) equipment with digital selective calling (DSC) function.

Maritime Safety Information (MSI) broadcast is available worldwide on HF narrow-band direct printing channels for Area 4 on the specified frequencies.

1.2.7. DSC – digital selective calling

The traditional marine radio (VHF/MF/HF) has been enhanced with the addition of a feature known as DSC. Great advantage of DSC comparing with traditional radio is automatic maintaining of the required watch on distress and calling channels, including VHF channel 16 (156.8 MHz) and 2182 kHz (used for distress, safety and calling), instead of the aural listening watch. Thus, the need for persons on a ship's bridge or on shore to continuously guard radio receivers on voice radio channels was eliminated.

A DSC receiver will only respond to the vessel's unique Maritime Mobile Service Identity number (MMSI#), similar to a telephone number, or to an "All Ships" DSC call within range. Once contact has been made by DSC, follow-up communication takes place by voice on another frequency.

Digital selective calling (DSC) on MF, HF and VHF maritime radios is a vital part of the GMDSS system. DSC is primarily intended to initiate ship-to-ship, ship-to-shore and shore-to-ship radiotelephone and MF/HF radiotelex calls. It is also used by ships and coast stations for relaying distress alerts and distress calls. Each DSC-equipped ship, shore station and group is assigned a unique 9-digit Maritime Mobile Service Identity. The content of a DSC call includes the numerical address of the station (or stations) to which the call is transmitted, the self-identification of the transmitting station and a message, which contains several fields of information indicating the purpose of the call.

DSC distress alerts, which consist of a preformatted distress message, are used to initiate emergency communications with ships and rescue coordination centres.

IMO and ITU both require that the DSC-equipped MF/HF and VHF radios be externally connected to a satellite navigation receiver (GPS). That connection will ensure that accurate location information is sent to a rescue coordination centre if a distress alert is transmitted. SOLAS requires checking the position of the ship not less than every 4 hours.

GMDSS telecommunications equipment should not be reserved for emergency use only. The International Maritime Organization encourages mariners to use GMDSS equipment for routine as well as safety telecommunications.

1.2.6. SART – search and rescue locating device

SARTs are portable radar transponders used to help locate survivors of distressed vessels, which have sent a distress alert. SARTs are detected by radar and therefore operate in the same frequency range as radars carried onboard most vessels – 3 cm radar display. SARTs transmit in response to received radar signals and show up on a vessel's radar screen on 6 nm range as a series of twelve dots indicating the line of direction of the SART. In the event that a ship must be abandoned, SARTs should be taken aboard survival craft. The detection range between these devices and ships, dependent upon the height of the ship's radar mast and the height of the search and rescue locating device, is normally about 5–7 nautical miles. Once detected by radar, the search and rescue locating device will produce a visual and aural indication to the persons in distress.

Some SART models nowadays are equipped with AIS transmitter, giving more accuracy and providing various additional information in ECDIS.

1.2.7. Power supply requirements

GMDSS equipment requires to be powered from three sources of supply:

- ship's normal alternators/generators (main power supply);
- ship's emergency alternator/generator (if fitted) (EDG); and
- a dedicated reserve source of energy supply (GMDSS radio battery).

In order to comply with SOLAS, the batteries require to have a capacity to power the equipment for 1 hour on ships with an emergency generator or built prior to February 1995, and for 6 hours on ships not fitted with an emergency generator or built after February 1995. The batteries must be charged by an automatic charger, which also requires to be powered from the main and emergency generators. Changeover from AC to battery supply must be automatic, and effected in such a way that any data held by the equipment is not corrupted ("no break").

When the reserve source of energy consists of batteries, the battery capacity must be checked at intervals not exceeding 12 months using the following procedure:

1 – daily test,	by crew;
2 – weekly test,	by crew;
3 – monthly test,	by crew;
4 – annual test,	by shore base service + certificate (not at sea).

Storage batteries provided as a reserve source of energy must be installed in accordance with applicable electrical codes and good engineering practice. They must be protected from adverse weather and physical damage. They must be readily accessible for maintenance and replacement.

1.3. GMDSS SEA AREAS

GMDSS sea areas are divided into four areas: A1, A2, A3, and A4.

GMDSS sea areas serve two purposes: to define areas where GMDSS services are available, and to define what radio equipment GMDSS ships must carry (carriage requirements). Prior to the GMDSS, the number and type of radio safety equipment that ships had to carry depended upon their tonnage. With

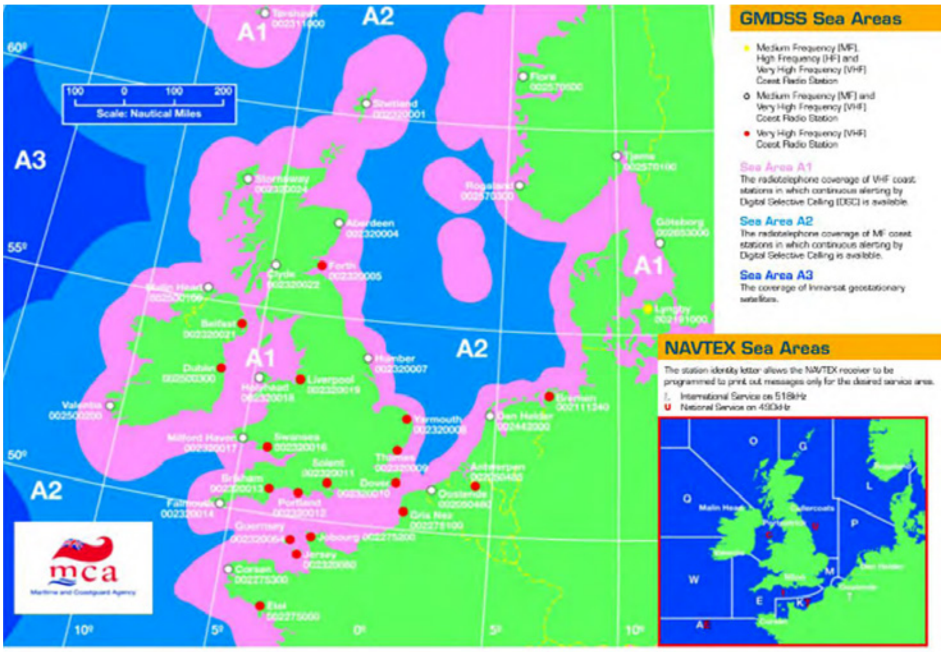

Fig. 1.4. Limits of sea areas – British Isles and North West Europe DSC (5. IMO Model Course 1.25, GOC for the GMDSS. 2015 Ed. Course and Compendium).

GMDSS, the number and type of radio safety equipment ships have to carry depends upon the GMDSS areas in which they travel.

- **Sea Area A1** (SOLAS Chapter IV, Reg. 2–12).
  An area within the radiotelephone coverage of at least one VHF coast station in which continuous digital selective calling (Ch.70/156.525 MHz) alerting and radiotelephony services are available. Such an area could extend typically 30 to 40 nautical miles from the Coast Station. Such an area could extend to typically 30 nautical miles from the Coast Station.
- **Sea Area A2** (SOLAS Chapter IV, Reg. 2–13).
  An area, excluding Sea Area A1, within the radiotelephone coverage of at least one MF coast station in which continuous DSC (2187.5 kHz) alerting and radiotelephony services are available. For planning purposes, this area typically extends to up to 150 nautical miles (280 km) offshore during daylight hours, but would exclude any A1 designated areas. In practice, satisfactory coverage may often be achieved to around 150 nautical miles (280 km) offshore during night time.
- **Sea Area A3** (SOLAS Chapter IV, Reg. 2–14).
  An area, excluding sea areas A1 and A2, within the coverage of an Inmarsat geostationary satellite. This area lies between 76 degrees North and South latitude, but excludes A1 and/or A2 designated areas. Inmarsat guarantees that its system will work between 70 degrees South and 70 degrees North latitude.
- **Sea Area A4** (SOLAS Chapter IV, Reg.2-15).
  An area outside Sea Areas A1, A2, and A3 is called Sea Area A4. These are essentially the polar regions, to the North and South from about 76 degrees latitude, excluding A1, A2, and A3 areas.

1. 4. GMDSS EQUIPMENT CARRIAGE REQUIREMENTS

Equipment requirements for GMDSS vessels vary according to the area (or areas) in which a ship operates. Coastal vessels, for example, only have to carry minimal equipment if they do not operate beyond the range of shore based VHF stations (Sea Area A1). Ships, which trade further from land are required to carry MF equipment in addition to VHF (Sea Area A2). Ships, which operate

Table 1.1

Minimum requirements for the composition of the radio equipment depending on the navigation area (A. Dominuks)

Equipment	A1	A2	A3 Inmarsat Solution	A3 HF solution	A4
VHF with DSC	x	x	x	x	x
DSC watch receiver Ch.70	x	x	x	x	x
MF telephony with MF DSC		x	x		
DSC watch receiver MF 2187.5 kHz		x	x		
Inmarsat SES with EGC receiver			x		
MF/HF telephony with DSC and NBDP				x	x
DSC watch receiver MF/HF				x	x
Duplicated VHF with DSC			x	x	x
Duplicated Inmarsat SES			x	x	
Duplicated MF/HF telephony with DSC and NBDP					x
NAVTEX receiver 518 kHz	x	x	x	x	x
EGC receiver	x[1]	x[1]		x	x
Float-free satellite EPIRB	x	x	x	x	x
Radar transponder (SART or AIS-SART)	x[2]	x[2]	x[2]	x[2]	x[2]
Hand-held GMDSS VHF transceivers	x[3]	x[3]	x[3]	x[3]	x[3]
For passenger ships the following requirements apply from 1 July 1997					
"Distress panel" (SOLAS regulation IV/6.4 and 6.6)	x	x	x	x	x
Automatic updating of position to all relevant radio communication equipment (regulation IV/6.5). This also applies for cargo ships from 1 July 2002 (Chapter IV, new Regulation 18)	x	x	x	x	x
Two-way on-scene radio communication on 121.5 and 123.1 MHz from the navigating bridge (SOLAS Regulation IV/7.5)	x	x	x	x	x

[1] Outside NAVTEX coverage area.

[2] Cargo ships between 300 and 500 gt: 1 set. Cargo ships of 500 gt and upwards and passenger ships: 2 sets.

[3] Cargo ships between 300 and 500 gt: 2 sets. Cargo ships of 500 gt and upwards and passenger ships: 3 sets.

beyond MF range, are required to carry HF and/or Inmarsat equipment in addition to VHF and MF (Sea Areas A3 and A4).

According to SOLAS, the following GMDSS equipment requirements are applicable for all passenger ships in international trade as well as cargo ships of 300 gross tonnage and upwards in international trade (including duplication of equipment) as shown in Table 1.1.

1.5. GMDSS EQUIPMENT DAILY, WEEKLY AND MONTHLY TESTING REQUIREMENTS

As the GMDSS equipment needs to function properly and effectively in the event of an emergency, navigating Officers must understand its purpose and do the required maintenance on board the vessel to keep it in a working condition and make the best use of GMDSS equipment. Daily, weekly and monthly tests of all installed GMDSS equipment should be done by every Navigating Officer responsible for it without any compromise.

1.5.1. Daily tests of GMDSS equipment

- The proper functioning of the Digital Selective Calling (DSC) facilities shall be tested at least once a day, without radiation of signals, by the use of the equipment's internal test facility. The daily test checks the internal connection, transmitting output power and the display. The process can differ from equipment to equipment based on the maker's instructions.
- Batteries providing reserve source of energy should also be checked daily. Mainly the battery ON LOAD and OFF LOAD voltages are checked by a voltmeter connected to the charger.
  OFF LOAD: when no equipment connected, the battery should read 25.5 – 29.0V not more.
  ON LOAD: switch off the AC power and note the voltage of the battery. Press the PTT on MF/HF transceiver on a non-distress and idle R/T frequency. Voltage will fall depending on the load. If the voltage falls by more than 10 %, it indicates that the battery is either weak or not charged fully. In this case, batteries should be recharged.
- All printers should be checked for working condition, cartridge and that there is sufficient supply of paper.

1.5.2. Weekly tests of GMDSS equipment

It is necessary to test the proper operation of the DSC facilities at least once a week by means of a test call over one of the six distress and safety frequencies, when within the communication range of a coast station fitted with a DSC equipment.

Test call on VHF/MF/HF unit to coastal station should be performed using built-in test procedure. After the test call has been sent successfully, the acknowledgement is received from the shore station. It often happens that the officer does not receive any acknowledgment from the shore station. In such cases to make sure that the VHF/MF/HF equipment is in order, test call should be sent using other frequencies and to other stations. If even then we fail to receive any acknowledgement, a test call shall be sent at a convenient time for best communication as soon as possible and recorded in log book – "No response / Long range". It is also possible to request them to send back a test call to ensure that the equipment receiving facility is functioning properly.

It is also recommended that a station-to-station test takes place using VHF DSC. This can be performed between own units if two VHF DSC stations are installed on the bridge.

1.5.3. Monthly tests of GMDSS equipment

EPIRB

The EPIRB should be using a self-test function. No signal is transmitted during the test. During the self test, the battery voltage, output power and frequency is checked. The EPIRB should also be checked for any physical damage. The expiry date of the battery unit and of the hydrostatic release unit should be checked. Also check that the safety clip is properly attached and in place.

SART

The search and rescue transponder is also equipped with a self-test mechanism to test the operational function of the beacon. The SART is tested using the ship's X band radar. The test should preferably be done in open seas to avoid interference on the radar display. On radar screen, you can see 12 circles within the 6 nm range.

NAVTEX

NAVTEX is an equally important GMDSS equipment and is the source of maritime safety information. It is also equipped with a test function that can test the battery, keyboard, LCD, ROM, and RAM. It is a good practice to test the NAVTEX and detect error if any.

BATTERY

The battery connections and compartment should also be checked. The level of the electrolyte and the specific gravity of each cell should be checked (if possible) and recorded. Sulfation can reduce the specific gravity thereby reducing the battery capacity. Maintenance of free batteries on board however do not require any such checks.

ANTENNAS AND CONNECTIONS

It is recommended to visually check every month all antennas for security of mounting and visible damage to the cables. The antennas are located on the monkey island. Any deposit of dirt and salt should be removed. It is also important to check the condition of the aerials and insulators together with the Electrical Officer. Ensure that the equipment is switched off and isolated before carrying out any work on the antenna.

1.6. RADIO PERSONNEL AND CERTIFICATION

Regulation IV/16 of the SOLAS Convention requires that every ship carries personnel qualified for distress and safety radio communication purposes to the satisfaction of the Administration. The personnel shall be holders of certificates specified in the Radio Regulations as appropriate, any one of whom shall be designated to have primary responsibility for radio communications during distress incidents.

There are six categories of certificates, shown in descending order of requirements, for personnel of ship stations and ship earth stations using the frequencies and techniques prescribed in ITU-R Chapter VII. An operator meeting the requirements of a certificate automatically meets all of the requirements of the following certificates:

- First-class radio electronic certificate;
- Second-class radio electronic certificate;
- General operator’s certificate;
- Restricted operator’s certificate;
- Long range certificate (for non-SOLAS vessels);
- Short range certificate (for non-SOLAS vessels).

After a period of 5 years, the certificates for service on SOLAS ships have to be revalidated.

1.7. WATCHKEEPING

Ships, whilst at sea, shall maintain a continuous watch appropriate to the sea area in which the ship is sailing (SOLAS Chapter IV, Reg. 12), using the following frequencies.

- VHF DSC channel 70.
- MF DSC distress and safety frequency 2187.5 kHz.
- HF DSC distress and safety frequencies: 8414.5 kHz and also on at least one of the distress and safety DSC frequencies 4207.5 kHz, 6312.0 kHz, 12577.0 kHz or 16804.5 kHz, appropriate to the time of day and the geographical position of the ship, if the ship is fitted with an MF/HF radio station. This watch may be kept by means of a scanning receiver.

- VHF channel 16, if practicable.
- An Inmarsat Ship Earth Station (SES) (if the ship is fitted with) for satellite shore-to-ship distress alerts.
- A radio watch for broadcasts of Maritime Safety Information (MSI) on the appropriate frequency or frequencies on which such information is broadcast for the area in which the ship is navigating.

A continuous watch for broadcasts of MSI shall also be kept for the area in which the ship is sailing by the following equipment:

- Inmarsat-C or Enhanced Group Call (EGC) SafetyNET receiver;
- HF NBDP (high frequency narrow band direct printing).

In addition to the distress and safety DSC frequencies ship stations should monitor automatically the DSC ship-to-ship routine calling frequency 2187 kHz in the MF band and the international routine DSC frequencies used by coast stations in order to receive public correspondence.

1.8. CALL CATEGORIES

In the GMDSS, there are 4 categories of priority.

- **Distress – MAYDAY**

The transmission of a distress alert and/or a distress call and message indicates that a mobile unit or person is threatened by grave and imminent danger and requires immediate assistance. Distress communications shall have priority over all other communications. Distress calls are immediately received by rescue authorities for action, and all vessels receiving a distress call are alerted by an audible signal.

A distress message consists of the word "MAYDAY" spoken three times in succession, which is the distress signal, followed by the distress message, which should include the following information:

- name of the vessel or ship in distress repeated three times;
- call sign or other identification;
- MMSI (if the initial alert is sent by DSC);
- her position (actual, last known or estimated expressed in lat./long. or in distance/bearing from a specific location);
- nature of the vessel distress condition or situation (e.g. on fire, sinking, aground, taking on water, adrift in hazardous waters);
- number of persons at risk or to be rescued, grave injuries;
- type of assistance needed or being sought;
- any other details to facilitate resolution of the emergency such as actions being taken (e.g. abandoning ship, pumping flood water), estimated available time remaining afloat.

The only person authorized to initiate distress sending is the Master.

EXAMPLE:

MAYDAY, MAYDAY, MAYDAY
THIS IS Sailboat Angela, Angela, Angela,
Call sign Sierra 5 Lima 1 2,
MMSI 278054321
POSITION 43° 26' North 020° 12' East AT 0630 UTC
The mast has broken and the engine is not strong enough to prevent us from grounding on a rocky shore.
IMMEDIATE ASSISTANCE REQUIRED.
5 persons on board and due to strong winds we can only remain on board for approximately two zero minutes.
OVER

- **Urgency – PAN-PAN**

The PAN-PAN call is the urgency signal that someone aboard a ship, aircraft, or other vehicle uses to declare that they have a situation that is urgent but, for the time being at least, does not pose an immediate danger to anyone's life or to the vessel itself.

The transmission of an urgency announcement indicates an urgent need for:

- assistance,
- a medical transport, or
- a medico call/message.

Urgency communications shall have priority over all other communications, except distress communication.

TYPICAL COMPOSITION OF URGENCY MESSAGE:

Pan-Pan, Pan-Pan, Pan-Pan
All stations, All stations, All stations
This is [vessel name and/ call sign] (spoken three times)
Call sign
MMSI
My position is ... [Details of the vessel's position].
I require... [Details of assistance required and other information].

- **Safety – SECURITÉ**

The transmission of a safety announcement and a safety call and message indicates the following information referring to the safety of navigation:

- weather conditions;
- nautical warnings;
- the ship's movement communication.

Safety communications shall have priority over all other communications, except distress and urgency communication.

EXAMPLE:

SECURITÉ, SECURITÉ, SECURITÉ
All stations, All stations, All stations
This is [vessel name] (spoken three times).
Call sign
MMSI
My position is ... [Details of the vessel's position].
Navigation warning... [Details of warning and other information].

- **Routine**

The transmission of a routine announcement and a routine call and message indicates that the following information does not refer to distress, urgency or safety. Routine communications shall have no priority.

1.9. IDENTIFICATION OF SHIP STATIONS

A ship station is a mobile station in the maritime mobile service located on board a vessel, which is not permanently moored, other than a survival craft station. Ships shall be identified by the following information:

- the official name of the ship preceded, if necessary, by the name of the owner on condition that there is no possible confusion with distress, urgency and safety signals;
- a call sign;
- its selective call number or signal.

Important!

- All transmissions shall be capable of being identified either by identification signals or by other means.
- All transmissions in the mobile services should carry identification signals.
- All transmissions with false or misleading identification are prohibited.

1.9.1. Ship's name

Normally the ship will be named by the owner of the vessel.

1.9.2. Call sign

All stations open to international public correspondence, all amateur stations, and other stations, which are capable of causing harmful interference beyond the boundaries of the territory or geographical area in which they are located, shall have call signs from the international series allocated to its Administration as given in the Table of Allocation of International Call Sign Series. The ITU assigns call sign series to each country.

Call signs are being formed in the following way:

- two characters and two letters, or
- two characters, two letters and one digit (other than the digits 0 or 1), or
- two characters (provided that the second is a letter) followed by four digits (other than the digits 0 or 1 in cases where they immediately follow a letter), or
- two characters and one letter followed by four digits (other than the digits 0 or 1 in cases where they immediately follow a letter).

1.9.3. Maritime Mobile Service Identity – MMSI

1.9.3.1. Ship's station

Ships participating in the maritime radio services should be assigned a nine-digit unique ship station identity – MMSI, where the first three digits represent the Maritime Identification Digits (MID) and last six digits are any figure from 0 to 9 – **MIDXXXXXX**. An important element of a MMSI is the MID. Each Administration has been allocated one or more MIDs for its use. The MID denotes the geographical area of the administration responsible for the ship station so identified. The MMSI of a vessel is assigned by an administration of a country under whose flag the vessel is sailing.

1.9.3.2. Coast station

In addition to the call sign, coast stations in the maritime radio services should be assigned a nine-digit unique coast station identity in the format **00MIDXXXX,** where the digits 3, 4 and 5 represent the MID and X is any figure from 0 to 9. The MID reflects the territory or geographical area in which the coast station or coast earth station is located.

1.9.3.3. Group calling

Group ship station call identities for calling simultaneously more than one ship are formed as follows: **0MIDXXXXX.** The MID represents only the territory or geographical area of the administration assigning the group station call identity and does not therefore prevent group calls to fleets containing more than one ship nationality.

1.9.3.4. Search and rescue (SAR) stations

When an aircraft has to use maritime mobile service identities for the purposes of conducting search and rescue communications with stations in the maritime mobile service, the responsible administration should assign a nine-digit unique aircraft identity, in the format 111MIDXXX.

1.9.3.5. Identification of aids to navigation (AtoN)

When a means of automatic identification is required for a station aiding navigation at sea, the responsible administration should assign a nine-digit unique number in the format 99MIDXXXX.

- 99MID1XXX Physical AIS AtoN;
- 99MID6XXX Virtual AIS AtoN.

1.9.3.6. Identification of associated craft with parent ship

Devices used on a craft associated with a parent ship need unique identification.

These devices, which participate in the maritime mobile service should be assigned a nine-digit unique number in format 98MIDXXXX. This numbering format is only valid for the devices on board of the crafts associated with a parent ship. A craft may carry multiple devices for which a MMSI is required. These devices may be located in lifeboats, life-rafts, MOB-boats or other craft belonging to a parent ship.

1.9.3.7. Identification of ship earth stations and coast earth stations (Inmarsat)

- Inmarsat-C starts with number 4; all in all it has 9-digits.
- Inmarsat Fleet77 starts with number 76; all in all it has 9-digits.

1.10. RADIO WAVE PROPAGATION

Three main physical mechanisms govern the propagation of radio waves.

- Line of sight.
- Ground wave.
- Sky wave.

Each frequency range has its own propagation characteristics.

The *Radio Frequency* (RF) spectrum is divided in several major bands.

- MF 300 – 4000 kHz Medium Frequency • Ground wave
- HF 4.0 – 27.5 MHz High Frequency • Sky wave
- VHF 28 – 300 MHz Very High Frequency • Line of sight
- UHF 300 – 3000 MHz Ultra High Frequency • Line of sight
- SHF 3 – 30 GHz Super High Frequency • Line of sight

Above 30 MHz, propagation is essentially by line-of-sight (*Fig. 1.5.*). In the case of terrestrial radio, this is accomplished via the lower part of the atmosphere – termed the troposphere – and in the case of space communication via earth-orbiting satellites.

Since land has poor ground conductivity, total cancellation does not occur in practice, as simple experiment with portable VHF FM receiver will show. However, the sea is a very good conductor, which means that maritime VHF antennas should be mounted well above the sea in order to avoid severe cancellation effects.

Within the frequency range of 4–30 MHz, ionospheric reflection is the controlling factor in achieving long-distance communication by radio waves. Because the ionization process in the upper atmosphere is responsible for this effect that is caused by the sun, it will be evident that the density of ionization varies depending on the time of day and the season of the year. The sunspot

Maritime VHF range: 156–174 MHz

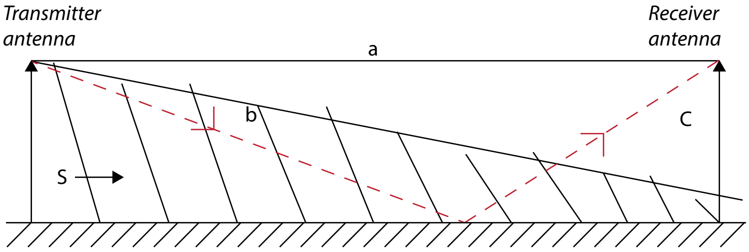

Fig. 1.5. *Line of sight propagation (5. IMO Model Course 1.25, GOC for the GMDSS. 2015 Ed. Course and Compendium).*

cycle, which takes approximately 11 years, also has an effect. Ionospheric storms and other disturbances occur from time to time and in extreme cases can cause a communication black-out lasting for some days. In general, the net result is that, to communicate over a given distance, a higher frequency is necessary when the density of ionization is high and a lower frequency when the density of ionization falls.

Long-distance propagation of radio waves at HF is mainly the result of single or multiple reflections from ionized regions in the upper atmosphere known collectively as the ionosphere. These ionized regions are generated at heights of 100–400 km (55–220 nm) as a result of partial ionization of the molecules making up the rare field upper regions (long wavelength x-ray solar radiation). The ionization process converts molecules into plasma of ions and free electrons.

MF propagation

During day time, communications depend mainly on ground-wave propagation but with a further reduction in range because of the increased effect of attenuation by the earth. A coast station can achieve good ground wave coverage for voice communications of up to 300 nm. Ship stations with less powerful transmitters and less elaborate antenna systems can usually expect reliable ground wave communications of up to 150 nm for voice communications and 300 nm for DSC/telex.

During night time, in addition to the ground wave propagation, sky wave propagation starts to become significant at MF, particularly at night, greatly extending the range. This can be a negative effect, however, owing to mutual interference between stations on the same frequency and interference fading caused by signals arriving at the receiver by different paths (ground wave and sky wave) from the transmitting station.

HF propagation. In practice a good guide to establishing reliable communication at HF is to monitor the transmission of the appropriate coast station channels, e.g. telex (NBDP), voice transmissions (weather report, traffic lists, etc.) on the more likely bands for the time of day and season and then call the station on whichever band providing a strong stable signal. If this is

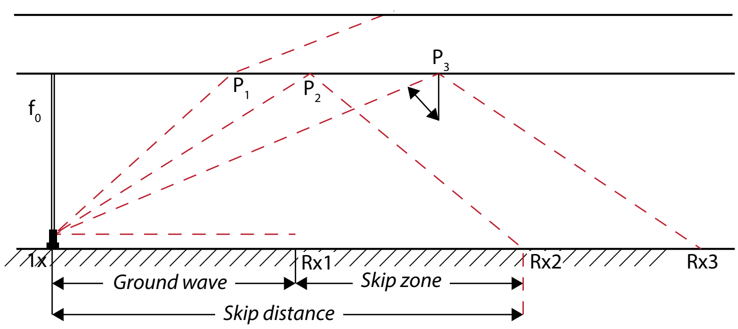

Fig. 1.6. *Ground waves and sky waves (5, IMO Model Course 1.25, GOC for the GMDSS. 2015 Ed. Course and Compendium).*

not successful, the other bands should be tried. The ionosphere can behave erratically at times, and on occasion, reception is better in the ship-to-shore direction than in the shore-to-ship direction, or vice versa. Communication is frequently unreliable around sunrise and sunset.

1.11. ACTION BY A SHIP IN DISTRESS

It is Master's responsibility to make and transmit a distress call in due time in case the vessel is to be abandoned or any immediate assistance is needed .

A ship in distress should transmit the distress call and message by all possible means on any one or more of the following international maritime distress frequencies as may be available:

- DSC VHF Ch.70;
- DSC MF 2187.5 MHz;
- VHF Ch.16 (156.8 MHz FM);
- 2182 kHz DSC MF 2187.5 MHz;
- Inmarsat-C terminal, if fitted;
- Inmarsat-F77 Phone, if fitted.

Important!

Adequate time should be allowed to receive replay before changing the frequency.

In the event of failure of the ship's radio station, distress call or signal must be transmitted using portable equipment (e.g. portable VHF radio stations, EPIRB, SART, etc).

DSC distress alert attempt will be transmitted as 5 consecutive alerts on the selected DSC distress frequency. To avoid alert collision and the loss of acknowledgements, this call attempt may be transmitted on the same frequency again after a random delay of 5 min from the beginning of the initial call. This allows acknowledgements arriving randomly to be received without being blocked by retransmission. The random delay will be generated automatically for each repeated transmission; however, it will be possible to override the automatic repeat manually.

Note:

The DSC distress alert on MF should be transmitted to all stations, on HF to an individual coast station.

Distress alerts shall normally be acknowledged by DSC by appropriate coast stations only. Acknowledgements by coast stations on MF/HF will be transmitted as soon as practicable.

The following information is to be included in the distress message:

- identification of the ship;
- position;
- nature of distress and kind of assistance required;
- any other information, which might facilitate the rescue (e.g. course and speed if under way, the Master's intention, including the number of persons, type of cargo, if dangerous);
- weather conditions in immediate vicinity, presence of navigational dangers;
- time of abandoning ship;
- number of crew remaining on board;
- number of seriously injured and other.

When requesting medical assistance for an ill or injured person, the following information should be provided:

- patient's name, age, gender, nationality and language;

- patient's respiration, pulse rate, temperature and blood pressure;
- location of pain;
- nature of illness or injury, including apparent cause and related history;
- symptoms;
- type, time, form and amounts of all medications given;
- time of last food consumption;
- ability of patient to eat, drink, walk or be moved;
- whether a suitable clear area is available for helicopter hoist operations or landing;
- name, address and phone number of vessel's agent;
- last port of call, next port of call and ETA.

1.12. ACTION BY SHIP UPON RECEIPT OF DSC DISTRESS ALERT

Ships receiving a DSC distress alert from another ship should keep watch on the radio telephony or radiotelex frequency in the same frequency band in which the distress alert was received. In the VHF/MF band ships **must acknowledge** the receipt of distress alert to ship in distress on VHF Ch.16/2182 kHz (voice).

Ships receiving a DSC distress alert on HF from another ship **shall not acknowledge** the alert.

If no DSC distress acknowledgement is received from a coast station within 5 min and no distress communication is observed going on between a coast station and the ship in distress, the ship that has received the distress alert must do the following:

- inform a Rescue Coordination Centre via appropriate radio communications means;
- transmit a DSC distress alert relay to a coast station.

The automatic repetition of a distress alert attempt should be terminated automatically on receipt of a DSC distress acknowledgement.

1.13. CANCELLING OF FALSE DISTRESS ALERT

A station transmitting an inadvertent distress alert or call shall cancel the transmission. According to IMO resolution A.814(19) the following steps should be taken in the case of accidentally false distress alert transmitted.

1.13.1. VHF

- Switch off the transmitter immediately**.
- Switch the equipment on and set to Channel 16.
- Make broadcast to "All Stations" giving the ship's name, call sign and DSC number, and cancel the false distress alert.

EXAMPLE:

All Stations, All Stations, All Stations
This is NAME, CALL SIGN,
DSC NUMBER, POSITION.
Cancel my distress alert of
DATE, TIME UTC,
Master's NAME, CALL SIGN,
DSC NUMBER, DATE, TIME UTC

1.13.2. MF

- Switch off the equipment immediately**.
- Switch the equipment on and tune for radiotelephony transmission on 2,182 kHz.
- Make broadcast to "All Stations" giving the ship's name, call sign and DSC number, and cancel the false distress alert.

EXAMPLE:
All Stations, All Stations, All Stations
This is NAME, CALL SIGN,
DSC NUMBER, POSITION.
Cancel my distress alert of
DATE, TIME UTC,
Master NAME, CALL SIGN,
DSC NUMBER, DATE, TIME UTC

1.13.3. HF

As for MF, the alert must be cancelled on all the frequency bands on which it was transmitted. Hence, the transmitter should be tuned consecutively to the radiotelephony distress frequencies in the 4, 6, 8, 12 and 16 MHz bands, as necessary.

1.13.4. Inmarsat-C

Notify the appropriate RCC to cancel the alert by sending a distress priority message via the same LES through which the false distress alert was sent.

NAME, CALL SIGN, IDENTITY NUMBER,
POSITION,
Cancel my Inmarsat-C distress
alert of DATE, TIME UTC
Master

1.13.5. EPIRBs

If for any reason an EPIRB is activated accidentally, immediately stop inadvertent transmission and contact the nearest coast station or an appropriate coast earth station or RCC and cancel the distress alert.

* Appropriate signals should precede these messages in accordance with the ITU Radio Regulations Chapter NIX.
** This applies when the false alert is detected during transmission.

1.14. DISTRESS TRAFFIC AND ON SCENE COMMUNICATION

On receipt of a distress alert or a distress call, ship stations and coast stations shall set watch on the radiotelephone distress and safety traffic frequency associated with the distress and safety calling frequency on which the distress alert was received. Distress traffic consists of all messages relating to the immediate assistance required by the ship in distress, including search and rescue communications and on-scene communications. The distress traffic shall as far as possible be on the frequencies contained in the RR (ITU Radio Regulation) Article 31.

For distress traffic by radiotelephony, when establishing communications, calls shall be prefixed by the distress signal MAYDAY.

The rescue coordination centre responsible for controlling a search and rescue operation shall also coordinate the distress traffic relating to the incident or may appoint another station to do so.

On-scene communications are those between the mobile unit in distress and assisting mobile units, and between the mobile units and the unit coordinating search and rescue operations. Control of on-scene communications is the responsibility of the unit coordinating search and rescue operations. Simplex communications shall be used so that all on-scene mobile stations may share relevant information concerning the distress incident. If direct-printing telegraphy is used, it shall be in the forward error-correcting mode.

The preferred frequencies in radiotelephony for on-scene communications are 156.8 MHz and 2182 kHz. Frequency 2174.5 kHz may also be used for ship-to-ship on-scene communications using narrow-band direct-printing telegraphy in the forward error correcting mode. In addition to 156.8 MHz and 2182 kHz, frequencies 3023 kHz, 4125 kHz, 5680 kHz and 156.3 MHz may be used for ship-to-aircraft on-scene communications.

The selection or designation of on-scene frequencies is the responsibility of the unit coordinating search and rescue operations. Normally, once an on-scene frequency is established, a continuous aural or teleprinter watch is maintained by all participating on-scene mobile units on the selected frequency.

The rescue coordination centre coordinating distress traffic, the unit coordinating search and rescue operations or the coast station involved may impose silence on stations, which interfere with that traffic. This instruction shall be addressed to all stations or to one station only, according to circumstances. In either case, the signal **SEELONCE MAYDAY** shall be used in radiotelephony:

SHIP'S NAME, CALL SIGN or ALL STATIONS
SEELONCE MAYDAY

Until they receive the message indicating that normal working may be resumed, all stations, which are aware of the distress traffic, which are not taking part in it, and which are not in distress, are forbidden to transmit on the frequencies in which the distress traffic is taking place.

When distress traffic has ceased on frequencies, which have been used for distress traffic, the station controlling the search and rescue operation shall initiate a message for transmission on these frequencies indicating that distress traffic has finished. In radiotelephony, the signal **SEELONCE FEENEE** is used and the message should consist of the following information:

MAYDAY
ALL STATIONS ALL STATIONS ALL STATIONS
THIS IS
SHIP'S NAME SHIP'S NAME SHIP'S NAME
CALL SIGN
MMSI
the time of handing in of the message in UTC
SHIP'S NAME, CALL SIGN and MMSI
(of the mobile station, which was in distress)
SEELONCE FEENEE

1.15. ON BOARD COMMUNICATION

The purpose of on board communication is the exchange of information regarding the operation of the own vessel on VHF or/and UHF channels. The power output is limited on VHF to 1W, on UHF to 2W.

The on board communication covers the following:

- internal communication on the vessel;
- communication between the parent ship and its life saving appliances;
- communication between the parent ship and its pram;
- communication while towing or mooring the vessel.

The identification of the controlling station (bridge) is the ship name followed by the word "Control". The identity of the first participating station (handheld) is the ship's name followed by the word "Alpha", for the second station it is the ship's name followed by the word "Bravo", etc.

THE EXAMPLE OF THE VOICE PROCEDURE:
Amarant Bravo
this is
Amarant Control
What is the distance to the berth? Over

1.16. RADIOTELEX

NBDP (narrow band direct printing) radio telex is the only means of communication in Sea Area A4. Thus written information on MF/HF regarding safety of navigation can be exchanged using radio telex only. For ships operating in Sea Area A4 radiotelex equipment is compulsory.

The purpose of radiotelex (NBDP) in the maritime mobile service is the exchange of information in direction ship-to-shore, shore-to-ship, ship-to-ship, and broadcast to all stations.

Two modes of operation are used depending on the message destination, and whether the message is addressed to one specific station or to all stations.

- ARQ – **A**utomatic **R**epeat re**Q**uest. This is the mode for communication between two stations to transmit and receive information during a certain connection. ARQ mode is used for one to one communication, for example when our ship wishes to communicate with a specific ship or coast station. At the end of the own transmission, the signals GA+? (Go Ahead) have to be keyed in to inform the receiving station that it now can start with its reply. The "+?" effects that the transmission permit has changed from one station to the other.

- FEC – **F**orward **E**rror **C**orrection. This is the mode for communication broadcasting to all stations or to transmit to an individual station in one direction only during a certain connection. This mode would be used, for example, for distress traffic or for NAVTEX broadcasts. In FEC mode you cannot switch between transmission and receiving mode.

1.17. USING A DIGITAL MULTIMETER

A digital multimetre (DMM) is an instrument for checking AC or DC voltages, resistance or current in circuits and insulations. This section discusses digital multimetre in *Fig. 1.7.*

The operation of a DMM, digital multimetre, itself is normally very straightforward. With knowledge of how to make voltage, current and resistance measurements it is a matter of putting the multimetre to use. When using the metre, it is possible to follow a number of simple steps.

- Turn the metre on.
- Insert the probes into the correct connections – this is required because there may be a number of different connections that can be used.
- Set a switch to the correct measurement type and range for the measurement to be made. When selecting the range, ensure that the maximum range is above that anticipated. The range on the DMM can then be reduced as necessary. However, selecting a range that is too high prevents the meter being overloaded.

Fig. 1.7. *Digital Multimetre (A.Dominuks).*

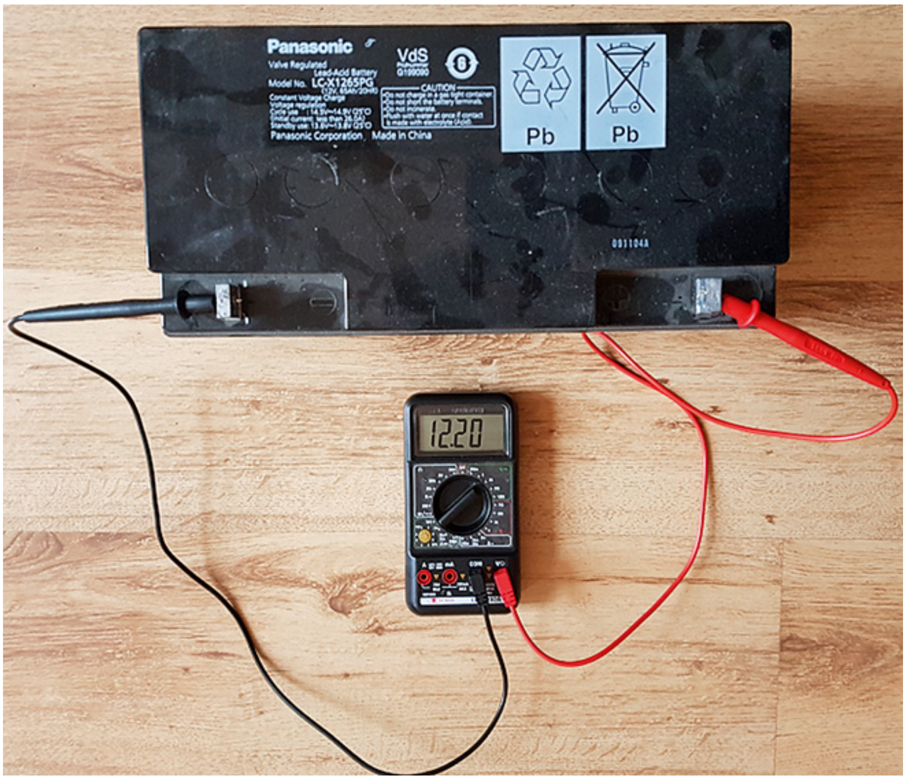

Fig. 1.8. *Battery measurement. (A.Dominuks).*

- Optimize the range for the best reading. If possible, enable all the leading digits not to read zero, and in this way the greatest number of significant digits can be read.
- Once the reading is complete, it is a wise precaution to place the probes into the voltage measurement sockets and turn the range to maximum voltage. In this way if the metre is accidentally connected without thought for the range used, there is little chance of damage to the meter. This may not be true if it is left set for a current reading, and the metre is accidentally connected across a high voltage point!

Use the Volt function to measure voltage. See the procedure below.

AC and DC modes are not compatible. The correct mode must be set → DC or AC. Insert the black probe into the "COM" jack (this is "–"). Insert the red probe into the "A" jack (this is "+"). When finished, do not forget to shut off power to the circuit. See the result in *Fig. 1.8.*

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PART 2

BRIDGE RESOURCE MANAGEMENT. JOINT SIMULATOR / CROSS BORDER TRAININGS, INCLUDING COMMUNICATION WITH ENGINE ROOM

SERGEJS STUPA

2.1. THE BRIDGE TEAM

All ship's personnel who have bridge navigational watch duties is part of the bridge team. The Master and pilot(s), as necessary, support the team, which comprises the Officer of the Watch (OOW), Helmsman and look-out(s) as required.

The OOW is in charge of the bridge and the bridge team for that watch, until relieved.

It is important that the bridge team works together closely, both within a particular watch and across watches, since the decisions made on one watch may have an impact on another watch.

The bridge team also has an important role in maintaining communication with the engine room and other operating areas on the ship.

2.1.1. The bridge team and the Master

It should be clearly established in the company's safety management system that the Master has the overriding authority and responsibility to make decisions with respect to safety and pollution prevention. The Master should not be constrained by a ship owner or charterer from taking any decision, which in his professional judgement is necessary for safe navigation, in particular in severe weather and in heavy seas.

The bridge team should have a clear understanding of the information that should be routinely reported to the Master, of the requirements to keep the Master fully informed, and of the circumstances under which the Master should be called.

When the Master has arrived on the bridge, his decision to take over control of the bridge from the OOW must be clear and unambiguous.

2.1.2. Working within the bridge team

Assignment of duties

- Duties should be clearly assigned, limited to those duties that can be performed effectively, and clearly prioritised.
- Team members should be asked to confirm that they understand the tasks and duties assigned to them.
- Positive reporting on events while undertaking tasks and duties is one way of monitoring the performance of bridge team members and detecting any deterioration in watchkeeping performance.

2.1.3. Co-ordination and communication

The ability of ship's personnel to co-ordinate activities and communicate effectively with each other is vital during emergency situations. During routine sea passages or port approaches the bridge team personnel must also work as an effective team.

A bridge team, which has a plan that is understood and is well briefed, with all members supporting each other, will have good situation awareness. Its members will then be able to anticipate dangerous situations arising and recognise the development of a chain of errors, thus enabling them to take action to break the sequence.

All non-essential activity on the bridge should be avoided.

2.2. MANOEUVRING CHARACTERISTICS AND INTERACTION

Introduction

Each ship has its own manoeuvring characteristics. The position of the pivot point will vary performance, while performance itself can be affected by numerous factors, not least, growth on the hull. The propellers of such varied construction these days can generate increased thrust with reduced cavitation, while "slip" and transverse thrust affects have as yet not been eliminated from propeller activity.

Interaction inside the marine environment is noticeable in several forms, where a ship can experience a reaction from a land mass or another ship, typically, a parent vessel reacting with a smaller tug – the weaker element with the stronger. Interaction can be observed as squat, a bank cushion affect, or just an unexpected movement between two vessels in close proximity.

Whatever form interaction takes, it is generally seen as undesirable and unwanted. Mariners have become familiar with its effects over the years and the industry has gone some way to educate our seamen in anticipation of what to expect. Bearing this in mind, it would seem obvious to avoid the experience if possible, or if it is going to be encountered, we should know how to counter its adverse effects. Many factors are associated with interaction, not least speed of the vessel, depth of water, proximity of obstructions, the hull form and the manoeuvring aids operational to the vessel. Some influences can be avoided or even eliminated with awareness and training, while improved navigation practice must be expected to lessen the dangers and make ship handling safer to the individual and better for the environment. The form of the land and the lack of underkeel clearance when vessels enter shallows will always be features worthy of special attention by the navigator and a ship's master. Pilotage will always be directly affected by the shallow water effect, while overall performance must encompass the elements derived from propeller action and the combined effects of the environment on the hull.

2.2.1. Manoeuvring information

It is now recommended that manoeuvring information in the form of a "Pilot Card", "Bridge Poster" and "Manoeuvring Booklet" should be retained on board ships. Such information should include comprehensive details on the following factors affecting the details of the ship's manoeuvrability, as obtained from construction plans, trials and calculated estimates.

Ship's general particulars should include the following: name, year of build and distinctive identification numbers; gross tonnage, deadweight, and displacement at summer draught; the principle dimensions, length overall, moulded breadth and depth, summer draught and ballast draught and the extreme height of the ship's structure above the keel.

List of main manoeuvring features: main engine, type and number of units, together with power output; the number and type of propellers, their diameter, pitch and direction of rotation; the type and number of rudders with their respective areas; bow and stern thruster units (if fitted), type and capacity.

Hull particulars: profiles of the bow and stern sections of the vessel and the length of the parallel of the middle body (respective to berthing alongside).

Manoeuvring characteristics in deep and shallow waters. Curves should be constructed for shallow and restricted waters to show the maximum squat values at different speeds and blockage factors, with the ship at variable draughts.

Main engine: manoeuvring speed tables established for loaded and ballast conditions from trials or estimated; stated critical revolutions and maximum/minimum revolutions; time periods to effect engine telegraph changes for emergency and routine operational needs.

Wind forces and drift effects. The ability of the ship to maintain course headings under relative wind speeds should also be noted together with the drifting effects on the vessel under the influence of wind, when the vessel is without engine power.

2.2.2. Manoeuvring characteristics in deep water

Course change performance: turning circle information from trials or estimates for various loaded/ballast conditions; test condition results reflecting "advance" and "transfer" and the stated maximum rudder angle employed in the test, together with times and speeds at 90°, 180°, 270°, and 360°; details should be in diagrammatic format with ship's outline.

Acceleration and speed characteristics – presentation of speed performance when the ship accelerates from a stopped position and deceleration from full sea speed to a position of rest, reflecting maximum rudder angles, for loaded and ballast conditions.

Stopping capabilities should include respective track stopping distances such as:

- full astern from a position of full ahead sea speed;
- full astern from a position of full ahead manoeuvring speed;
- full astern from half ahead;
- full astern from slow ahead;
- stopping engine from a position of full sea speed ahead;
- stopping from a position of full manoeuvring speed ahead;
- stopping engine from half ahead;
- stopping engine from slow ahead.

Relevant time intervals should also be recorded, reflecting the time to reach full ahead and positions of zero speeds, compatible with the above operations.

Information on the minimum speed (rpm) at which the ship can retain steerage capability.

2.2.3. Forces acting on the ship

Controllable forces

- Propellers.
- Rudders.
- Thrusters.
- Anchors.
- Ropes.
- Tugs.

Uncontrollable forces

- Tides and currents.
- Wind.
- Ice over navigable water.

Semi controllable forces

- Shallow water effects (squat, bank effect).
- Passing ship effects (meeting, overtaking).

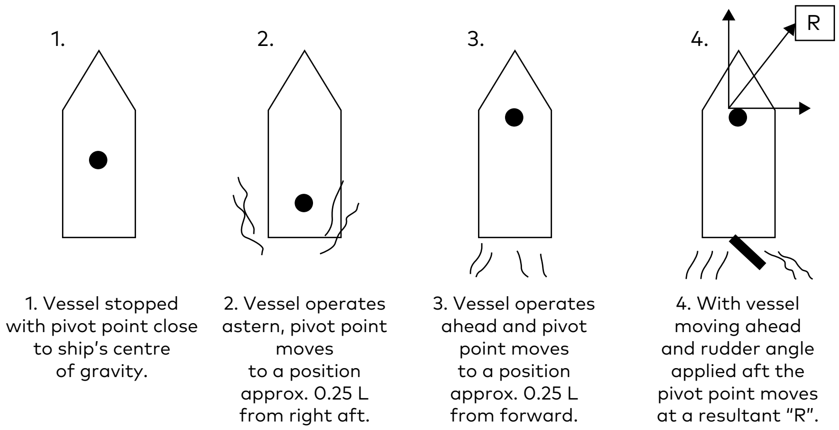


Fig. 2.1. *The ship's pivot point (D. J. House).*

2.2.4. The ship's pivot point

The turning effect of a vessel will have an effect on the ship's "pivot point", and this position, with the average design vessel, lies at about the ship's centre of gravity, which is generally nearly amidships (assuming the vessel is on even keel in calm water conditions).

As the ship moves forward under engine power, the pivot point will be caused to move forward with the momentum of the vessel. If the water does not exert resistance on the hull, the pivot point would assume a position in the bow region. However, practically the pivot point moves to a position approximately **0.25** of the ship's length (L) from the forward position.

Similarly, if the vessel is moved astern, the stern motion would cause the pivot point to move aft and adopt a new position approximately **0.25** of the ship's length from the right aft position.

If the turning motion of the vessel is considered, with use of the rudder, while the vessel is moved ahead by engines, it can be seen that the pivot point follows the arc of the turn.

When the vessel is moving ahead and turning at the same time, the forces on the ship affect either side of the pivot point, as shown in Fig. 2.2.

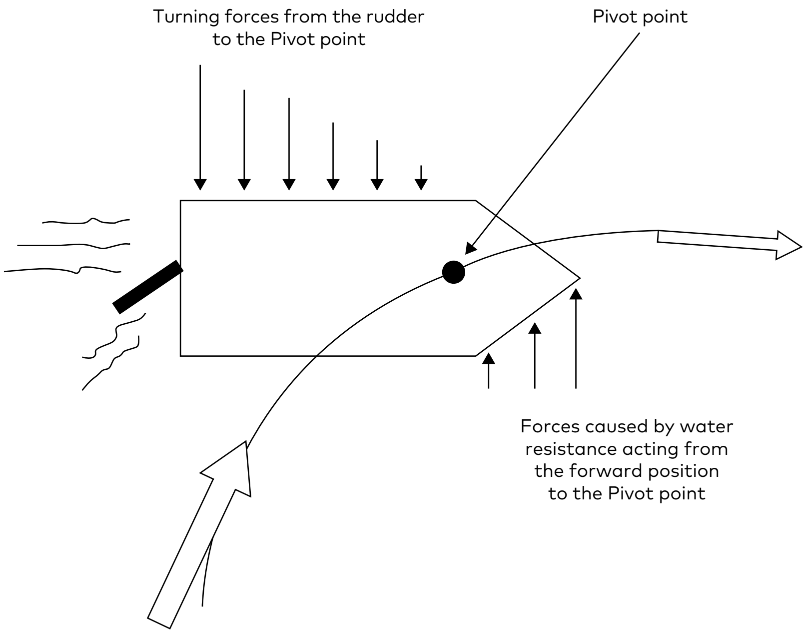


Fig. 2.2. *The ship's pivot point; vessel is moving ahead and turning (D. J. House).*

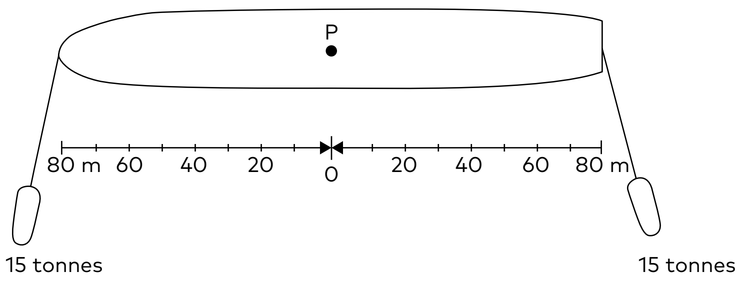


Fig. 2.3. *Turning levers – vessel stopped (Pluzhnikov).*

The combined forces of water resistance, forward of the pivot point and the opposing turning forces from the rudder, aft of the pivot point, cause a "couple effect" to take place. The resultant turning motion on the vessel sees the pivot point following the arc of the turn.

2.2.5. Turning levers and moments

More important perhaps, than the position of the pivot point, is the effect its shifting nature has upon the many turning forces that can influence a ship. These are rudder force, transverse thrust, bow thrust, tug force, interactive forces and the forces of wind and tide.

2.2.5.1. Vessel stopped

If we look at the ship used in our example, we can see that it has an overall length of 160 metres. It is stopped in the water and two tugs are secure fore and aft, on long lines, through centre leads. If the tugs apply the same bollard pull of say 15 tonnes each, it is to a position 80 m fore and aft of the pivot point. Thus two equal turning levers and moments of 80 m × 15 t (1200 tm) are created resulting in even lateral motion and no rate of turn.

2.2.5.2. Making headway

With the ship making steady headway, however, the pivot point has shifted to a position 40 m from the bow. The forward tug is now working on a very poor turning lever of 40 m × 15 t (600 tm), whilst the after tug is working on an extremely good turning lever of 120 m × 15 t (1800 tm). This results in a swing of the bow to starboard.

2.2.5.3. Making sternway

The efficiency of the tugs will change totally when the ship by contrast makes sternway. Now the pivot point has moved aft to a position 40 m from the stern. The forward tug is working on an excellent turning lever of 120 m × 15 t (1800 tm) whilst the after tug has lost its efficiency to a reduced turning lever of 40 m × 15 t (600 tm).

This now results in a swing of the bow to port.

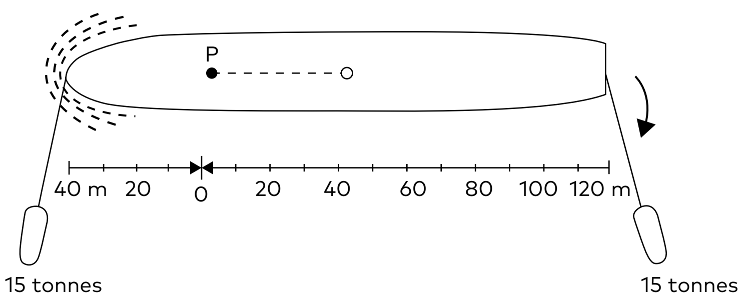


Fig. 2.4. *Turning levers – making headway (Pluzhnikov).*

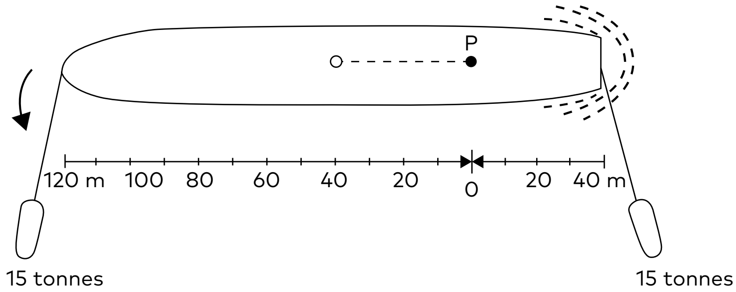


Fig. 2.5. *Turning levers – making sternway (Pluzhnikov).*

This simple method can also be used to obtain a basic knowledge of rudder, propeller and thruster efficiency, effect of wind, trim, interaction and tug positioning. In each Session that discusses those particular subject areas and in practical exercises in the manned models, it is the basis of all analysis!

2.3. SLOW SPEED CONTROL

Many casualties are proven to occur as a direct result of excessive speed. Its effect can be insidious and a master may find that he cannot keep up with events, which are happening too quickly. Effective control of the ship is slowly but inexorably lost. Against this there are commercial pressures, on masters and pilots alike, for expedient passages and turn-round times. Whilst there are arguments either way, they are clearly not compatible, experience has shown that a fast pilot is not necessarily a good pilot – just lucky!

It is therefore desirable to balance a safe and effective speed of approach, against a realistic time scale. It would be unwise, for example to conduct a three mile run-in at a speed of one knot. Three hours would stretch anyone's patience!

It is, of course, impossible to give exact figures, the requirement is dictated to a large degree by variable factors, such as the type of ship, tonnage, draft, shaft horse-power, wind and tide. Generally speaking, ships of less than 40,000 dwt are inclined to run their way off relatively quickly when engine speed is reduced, whereas larger ships carry their way for much larger distances. Speed must be brought firmly under control at greater distances from the berth.

It is usually obvious when the speed of a ship is too slow and can be easily overcome with a small increase in revolution; it is not always obvious when the speed is too high. The speed of a large ship, during an approach to a berth, particularly without tugs, can increase in an insidious manner and it is invariably difficult to reduce that speed in a short distance and keep control of the ship.

One of the biggest worries is the loss of rudder effectiveness and the fear that we cannot keep control of the ship's head at very slow speeds, particularly without any tug assistance. For a variety of reasons, such as poor steering, wind, tide, shallow water or directional instability, the bow may well begin to develop an unwanted sheer, also it may be desirable to adjust the attitude of approach.

Control is best achieved by applying full rudder and utilizing a short but substantial burst of engine power. **This is the "kick ahead" technique.**

Figure 2.6 illustrates some important points. In this example we have a medium size ship of 60,000 dwt, which we will assume is diesel powered, with a single, right handed, fixed pitch propeller and a single conventional rudder.

At one mile from the berth, running at an approach speed of 6 knots, it is well in excess of the ship's dead slow speed of 3 knots. As the ship approaches the 1/2 mile mark, the speed is still over 3 knots, despite a rapid reduction in rpm. It is now necessary to stop the engine and hence sustain a prolonged period of increasing stern power, in order to stop the ship in time. During this substantial

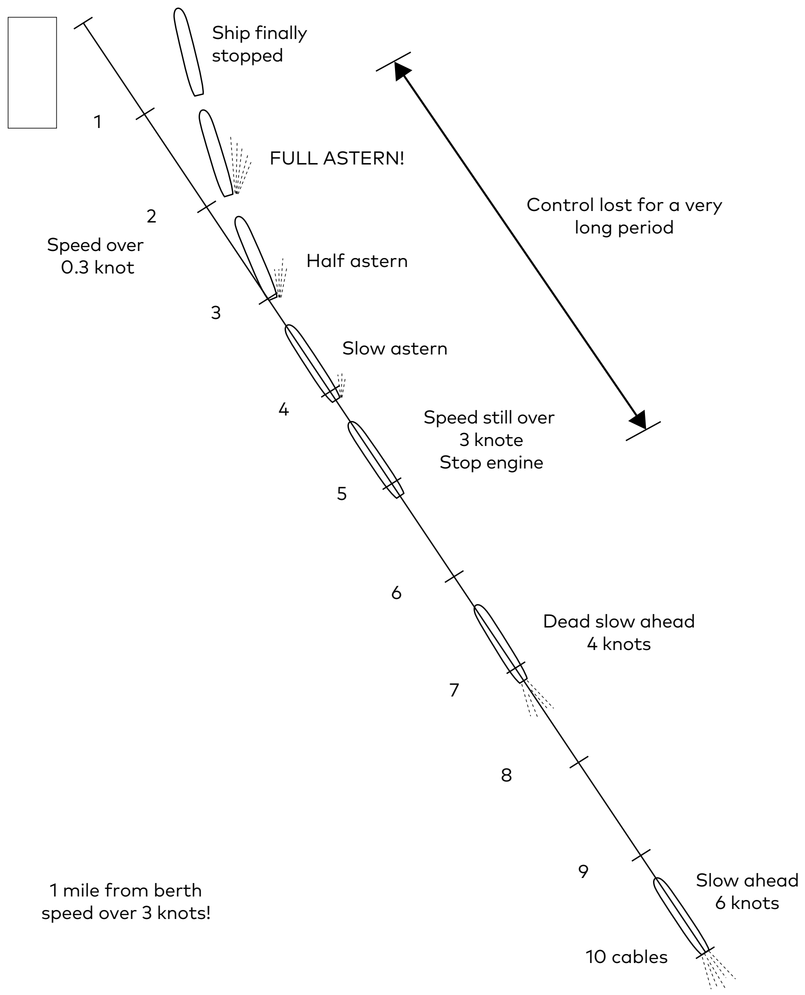


Fig. 2.6. *Loss of slow speed control (Pluzhnikov).*

time interval, the ship is at the whim of transverse thrust, wind, tide and bank or shallow water effect. It is effectively "out of control" in so much that we can only stand back and hope that it will do what is required. This is literally a hit or miss situation and the more we can reduce this prolonged period of increasing stern power and thus retain control, so much the better!

2.3.1. Maintaining slow speed control

In Fig. 2.7, we see the same ship, again one mile from a berth but this time at its dead slow speed of 3 knots or less. Before it approaches the one mile mark, it may also be necessary to stop the engine to further reduce the headway and allow plenty of time for adjusting the ship's approach and positioning for the berth. Several things should be done, when kick ahead technique is used.

Kick ahead-rudder angle

If a kick ahead is to be utilised, it is essential that the rudder is seen to be "hard over" before the power is applied. Whilst this ensures a maximum rudder turning force, it also "puts the brake" on some of the residual speed, directly resulting from increased power. With the helm at anything less, such as 15° or 20°, less rudder force is applied at the cost of increasing forward speed. It is also essential that the power is taken off before the rudder is returned to amidship or to an angle of less than 35°. Failure to do this will result in a brief but important interval during which most or all of the power applied is again being used to increase speed.

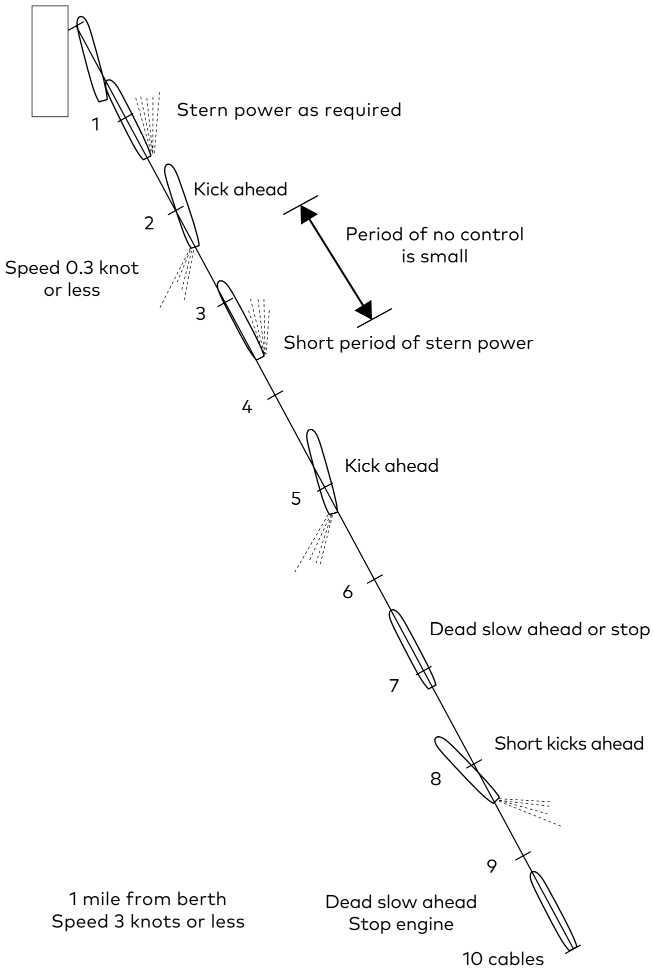


Fig. 2.7. *Slow speed control (Pluzhnikov).*

Kick ahead duration, kick ahead power

The duration of a kick ahead, should be as short, as possible. Prolonged use of power after the initial steering effect has ceased will only result in a violent sheer and an unwanted build up of speed. This, will result in the need for yet another kick ahead to rectify the situation. As soon as the revolutions reach the required maximum, the power must be taken off.

It is difficult to quantify the amount of power to be applied for a kick ahead, as it very much depends on the size of ship and the needs of the ship handler at the time. It is important, however, to appreciate the ratio of shaft horse power to tonnage that differs from ship to ship.

2.4. BOW THRUSTER WORK

Specific aspects of bow thruster work.

- Thrusting when a ship is stopped.
- The thruster and headway.
- Working the thruster with sternway.

2.4.1. Thrusting when a ship is stopped

When a ship is stopped and the bow thruster is activated, to thrust the bow in the desired direction, it is working on a pivot point, which is located well and (due to the underwater profile of the ship) in aft position, which

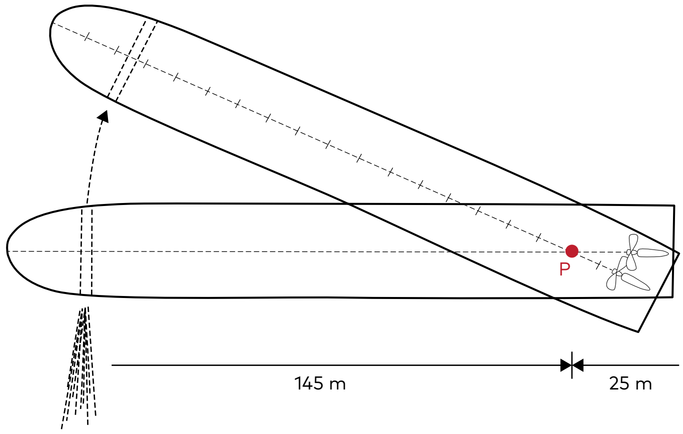


Fig. 2.8. *Thrusting when stopped – pivot point (Pluzhnikov).*

is roughly the equivalent of one ship beam from the stern. If the thruster is modest, 10 tonnes bollard pull will give it a turning moment of ***10 t × 145 m = 1450 tm.***

2.4.2. Thrusting when headway

When using a bow thruster while a ship is making headway, the first limitation is that imposed by too high a speed. With the exception of a few powerful units and multi-thruster units, performance will fall off quite rapidly once the ship's speed has risen above 2 knots or thereabouts. At higher speeds, turbulence will develop at the tunnel entrances, spreading through the tunnel to seriously impair propeller performance. Externally, the increasing water flow across the tunnel mouth soon deflects the meagre thruster output. In an attempt towards improving this, some manufacturers have altered the shape of the tunnel apertures, thus improving water flow through the tunnel, but despite this, excessive speed will probably still be detrimental to thruster efficiency.

Less obvious, but much more important, is the position of the ship's pivot point, which, when a vessel is making headway but not turning, is approximately 1/4 of the ship's length from the bow. Due to that, the thruster has a very short turning lever, in this case 25m, and the resultant turning moment is poor: ***10 t × 25 m = 250 tm***

This illustrates the main reason for a reduction in the thruster's turning ability as the ship gathers headway, in comparison with the previous example, when the ship was stopped.

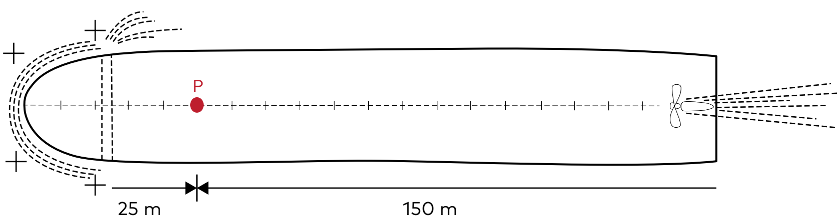


Fig. 2.9. *Thrusting with headway – not turning (Pluzhnikov).*

2.4.3. Thrusting with sternway-pivot point

The thruster can be used to steer the ship very effectively as it makes sternway in much the same manner as a rudder and although it does not take long to get the feel of it, one or two following points are worth keeping in mind:

- the thruster may be slow coming up to full power;

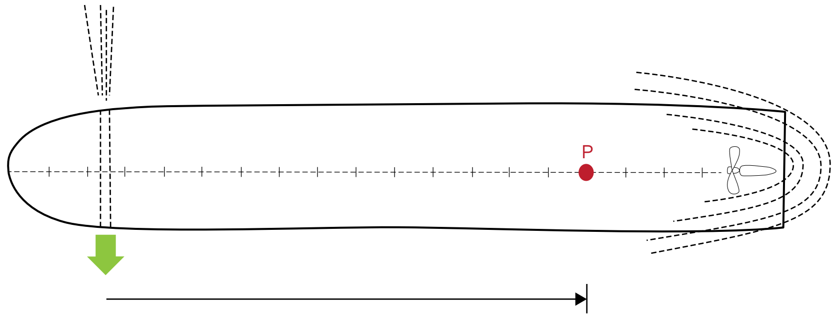


Fig. 2.10. *Thrusting with sternway – pivot point (Pluzhnikov).*

- the ship will steer quite sluggishly with a tendency to "flop" to either side of the intended direction if permitted to do so;
- the thruster will be slow correcting any large rate of turn;
- looking astern from a bridge aft, the eye does not perceive the rate of turn as quickly as it would when looking forward to the bow.

2.4.4. Turning

Turning in deep water

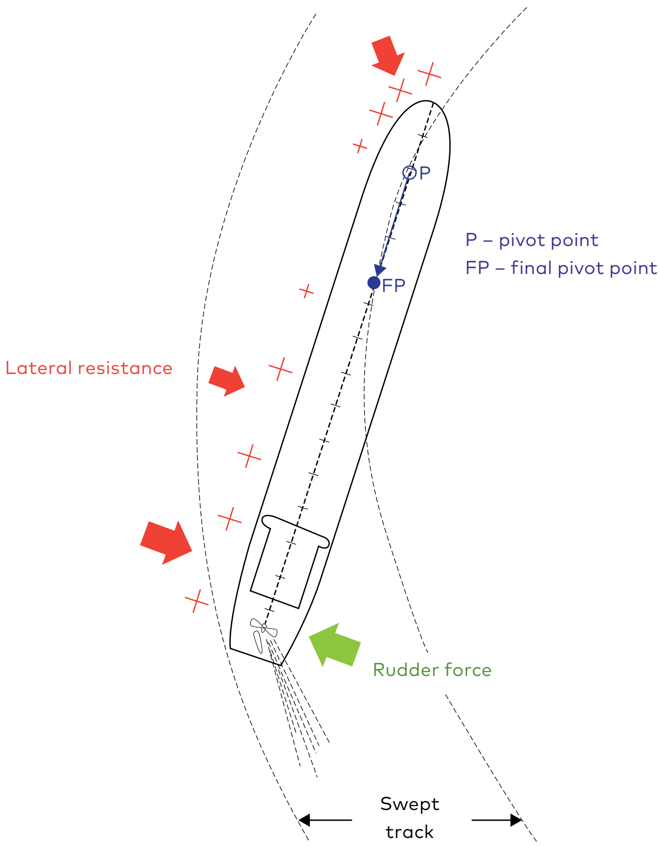


Fig. 2.11. *Standing turn – lateral resistance (Pluzhnikov).*

Speed during a turn

The speed of a ship during a normal turn is interesting in so much that it suffers a marked reduction. As the ship is sliding sideways and ahead, the exposed side experiences a substantial increase in water resistance, which in turn acts as a brake. The ship may experience a 30 to 50 % speed loss and it is a useful feature in many areas of ship handling where a sharp speed reduction is required.

2.5. SHALLOW WATER

So far, we have only considered a ship manoeuvring in deep water. If, however, the ship is operating in shallow water, it is likely to have considerable effect upon handling, in particular its turning ability. As a rough guide it can be assumed that a ship may experience shallow water effect when the depth of water is less than twice the draft, i.e. the under keel clearance is less than the draft itself. Serious cases of shallow water problems have however been experienced with larger under water clearances, especially at high speeds, sometimes with dire consequences!

2.5.1. Increase of draft in turning in shallow water

To look more closely at the problem, we will return to the example ship, which is fully loaded and on even keel with a draft of 11.6 meters. This vessel is commencing a full starboard rudder turn, with a three meter under keel clearance. Looking at the ship from astern, it can be seen, as the stern of the ship commences to sweep to port, that water pressure is building up along the port side, abaft of the pivot point due to the restriction under the keel.

In the first instance the rudder force now has to overcome a much larger lateral resistance and is therefore considerably less efficient. A similar thing is happening at the bow, because of the reduced under keel clearance water, which would normally pass under the ship, is now restricted and there is a build up of pressure, both ahead of the ship and on the port bow. This now upsets the balance between the ship's forward momentum and longitudinal resistance and pushes the pivot point back from P to PP. With the steering, or rudder lever also reduced the ship is rapidly losing the rudder efficiency enjoyed in deep water.

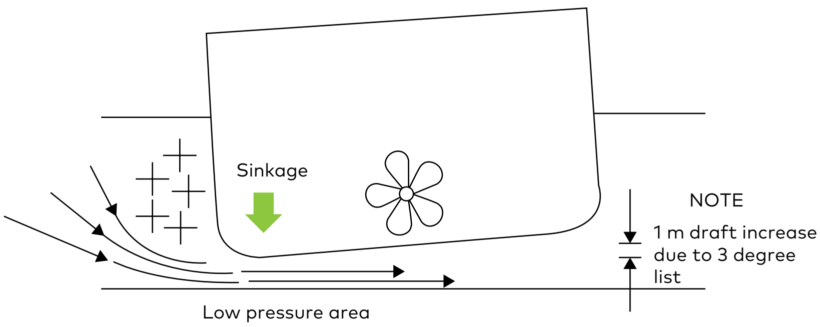


Fig. 2.12. *Shallow water (water pressure) (Pluzhnikov).*

2.5.2. Turning in deep and shallow water

Table 2.1

Manoeuvring Characteristics in Deep and Shallow Water

	Shallow water	Deep water
Turning circle diameter	Twice greater	About 3x the ship's length
Rate of turn	Less	Greater
Speed loss in turn	Less	Greater
Astern engine effectiveness	Less	Greater
Crash stop distance	Greater	Less
Directional stability	Greater	Less

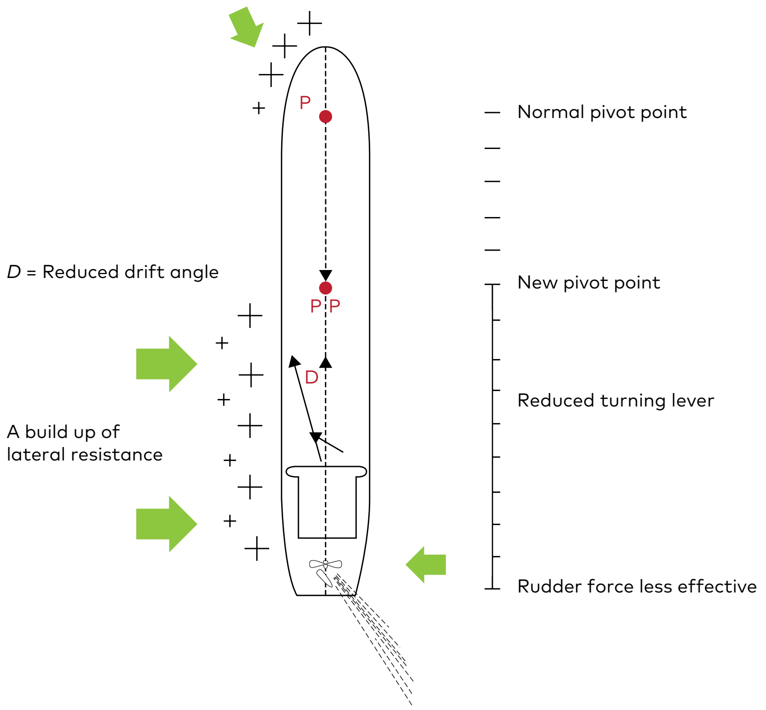


Fig. 2.13. *Shallow water (pivot point) (Pluzhnikov).*

When the ratio of depth to draft of the ship (H / T) is reduced, the effect is increased and vessel's manoeuvring characteristics are considerably changed. The reasons for the change of characteristics are the following:

- water flow around the hull has changed;
- the hydrodynamic mass of the ship increases strongly;
- the forces that affect the ship will increase considerably.

To sum up, this is what happens in shallow water.

1. The ship becomes slower.
2. The acceleration time increases.

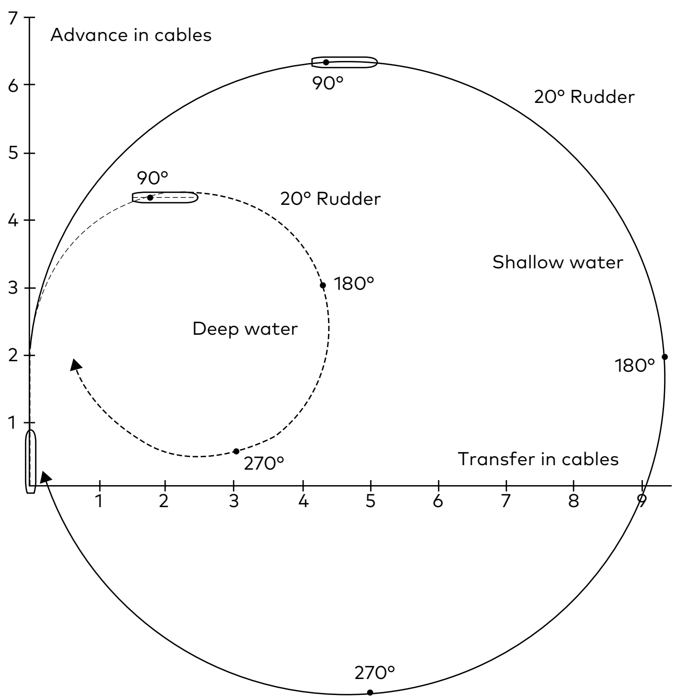


Fig. 2.14. *Full ahead turns to starboard (Pluzhnikov).*

3. Stopping time and distance increases (when course deviation is controlled).
4. Turning radius increases.
5. Pivot point moves towards the centre of gravity.

2.6. SQUAT EFFECT

Squat is caused by an interaction of the hull of the ship, bottom and the water between. In other words, squat is a reduction of vessel's underkeel clearance.

A speed making vessel push the mass of water in front of her bow. The water must flow back under and by the sides of the vessel (backflow) to replace the water displaced by the ship's hull. In shallow and/or narrow waters, the water particles increase the velocity of flow, which results in a pressure drop.

Bernoulli's law:

$$p/\gamma + v^2/2g = \text{const} \quad (2.1)$$

where

p – water pressure;

γ – water density;

g – acceleration of gravity.

The reason for draft changing is the fact that when the ship is moving, she is pushing the water away, the water obtains a rate of speed and at the same time there is a reduction in the static fluid pressure. This is an unbalance between the vessel's weight and the buoyancy from the original displaced liquid volume. The two forces are brought into balance by the ship sinking deeper into the fluid.

The main factors affecting the size of squat are the following:

- present water depth;
- ship's speed through water;
- ship's block coefficient (Cb);

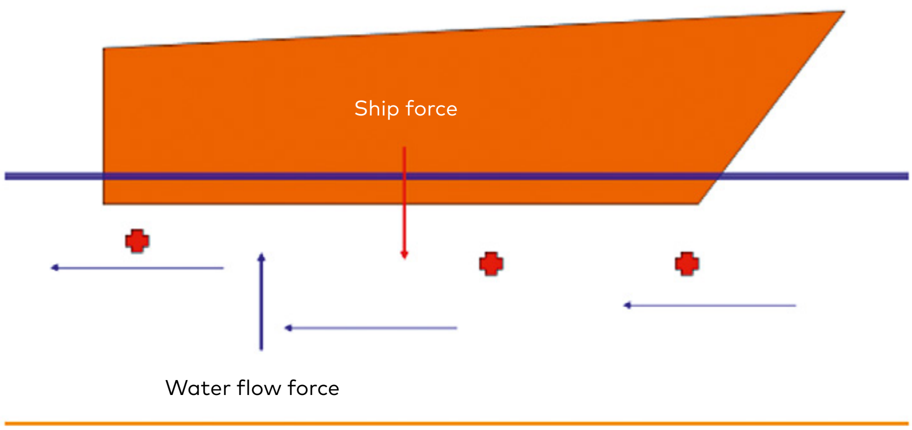


Fig. 2.15. *Pressure zones in deep water (Pluzhnikov).*

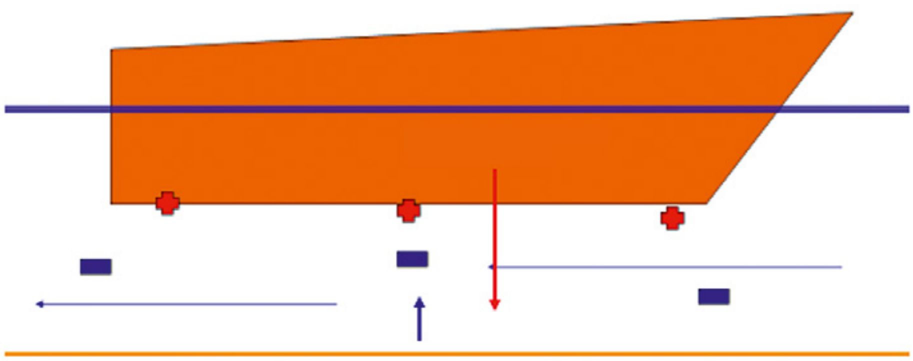


Fig. 2.16. *Pressure zones in shallow water (Pluzhnikov).*

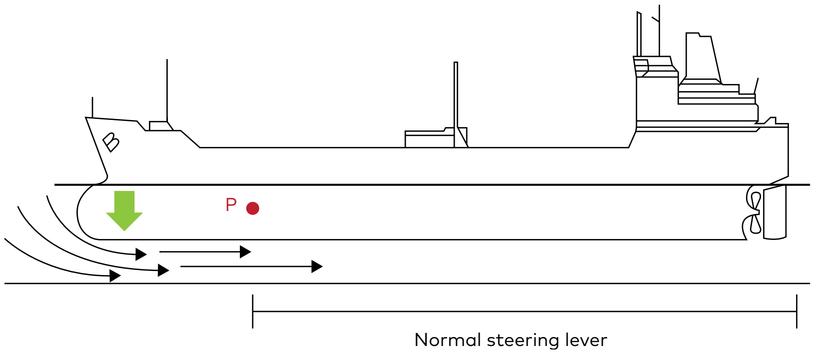


Fig. 2.17. *Ship in shallow water (Pluzhnikov).*

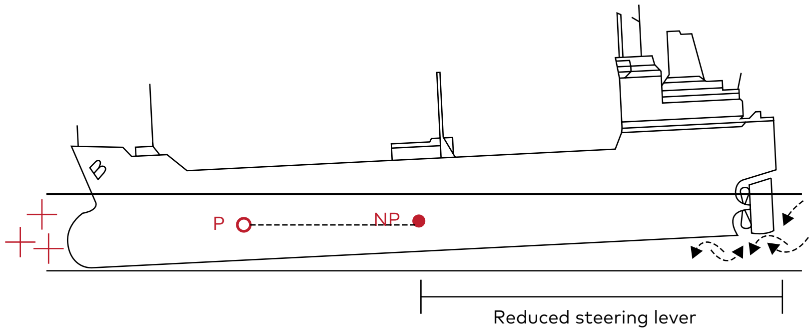


Fig. 2.18. *Effect of squat (water pressure) (Pluzhnikov).*

- whether a vessel is sailing in shallow and unrestricted waters or shallow and restricted waters.

Formula for squat calculation in unrestricted waters:

$$\text{Squat} = \text{Cb} \times V^2/100 \text{ (metres)} \quad (2.2)$$

where V is speed through the water in knots.

Formula for squat calculation in restricted waters:

$$\text{Squat}=\text{Cb} \times V^2/50 \text{ (metres)} \quad (2.3)$$

where V is speed through the water in knots.

2.7. BANK, CHANNEL AND INTERACTION EFFECTS

When a ship is making headway, a positive pressure area builds up forward of the pivot point whilst aft of the pivot point the flow of the water down the ship's side creates a low pressure area. This area extends out from the ship and in deep, open water, clear of other traffic is not a problem.

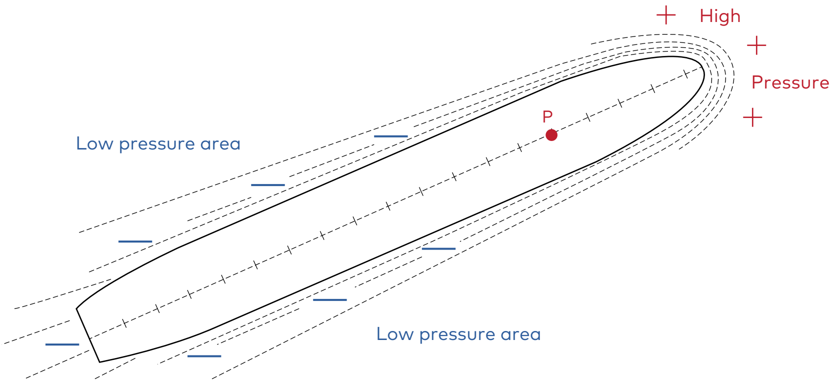


Fig. 2.19. *Pressure zones in deep water (Pluzhnikov).*

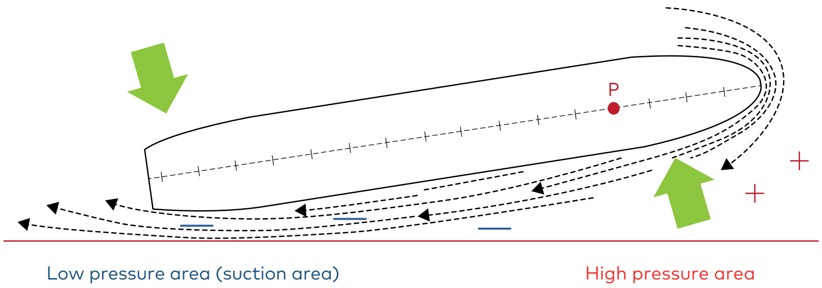


Fig. 2.20. *Bank effect (Pluzhnikov).*

If however the ship commences to close a vertical obstruction, such as shoal or canal bank, the area experiences some kind of restriction and the ship will be influenced by the resultant forces, which build up. As a result of these two forces, which have been developed, the stern of the ship is likely to be sucked into the bank. It can be very difficult to break out of its hold, the ship requires constant corrective rudder and power, sometimes hard over in order to control heading.

2.7.1. Interaction of vessels

It is important at this stage, when meeting another ship, not to work over to the starboard side of the channel too early or too far. If the ship gets too close to a shoal or bank, it can experience bank effect and unexpectedly sheer across the path of the approaching ship with appalling consequences. As the two bows approach each other, the combined bow pressure zone between them will build up and encourage the respective bows to turn away from each other. Helm may be required to check the swing.

With two ships nearly abeam of each other, a combined low pressure, or suction area exists between them and, if the vessels are too close together there is likelihood of them being sucked together in a collision. At this stage, the bow of each ship will also begin to feel the low pressure area astern of the other. It is usual to feel this “turning in” towards the other ship as you pass and it is helpful because it turns back towards the centre of the channel.

Having previously turned in towards the centre of the channel, the opposite now occurs. As the two sterns pass each other, they are drawn together by the low pressure area between them and this has a tendency to realign the ships with the channel.

These effects are not always very noticeable even at relatively slow speeds, because the ships often pass through the pressure zones fairly quickly. The effects, however, should always be anticipated and used correctly to advantage, corrective helm being applied when necessary.

The following general points should be noted.

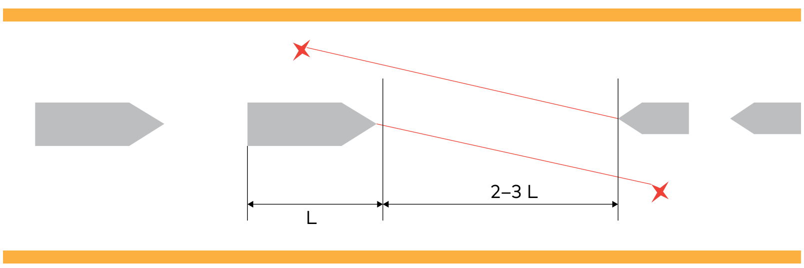


Fig. 2.21. *Distance to the start of the manoeuvre for safe passage (Pluzhnikov).*

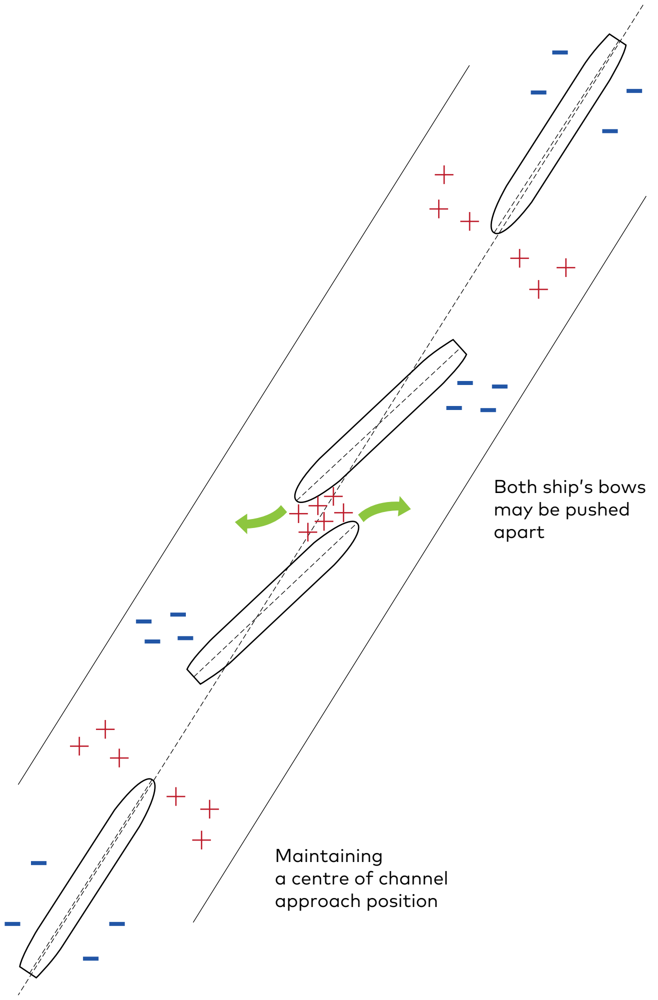


Fig. 2.22. *Passing – Phase 1 (Pluzhnikov).*

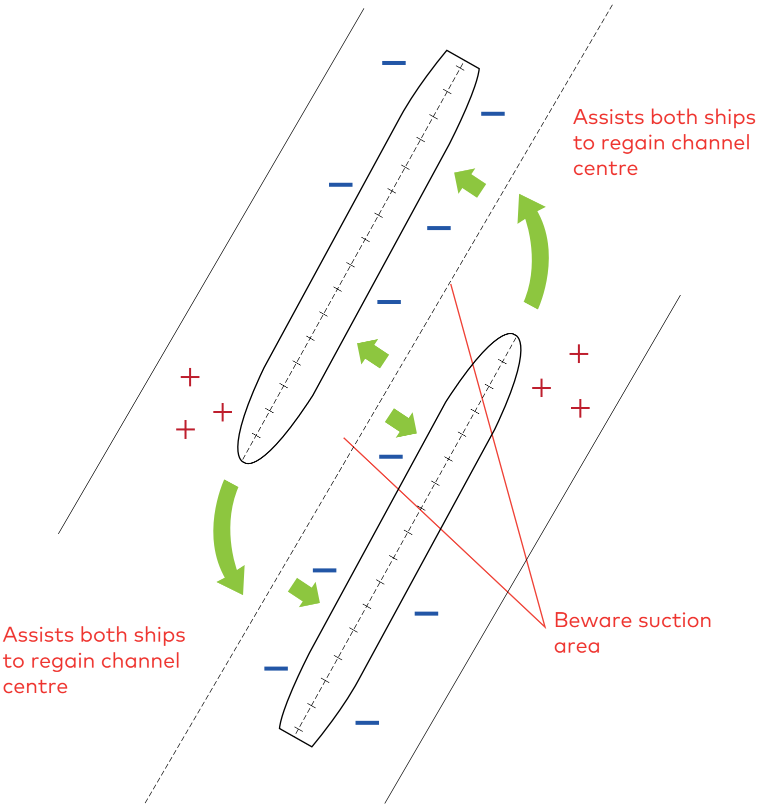


Fig. 2.23. *Passing – Phase 2 (Pluzhnikov).*

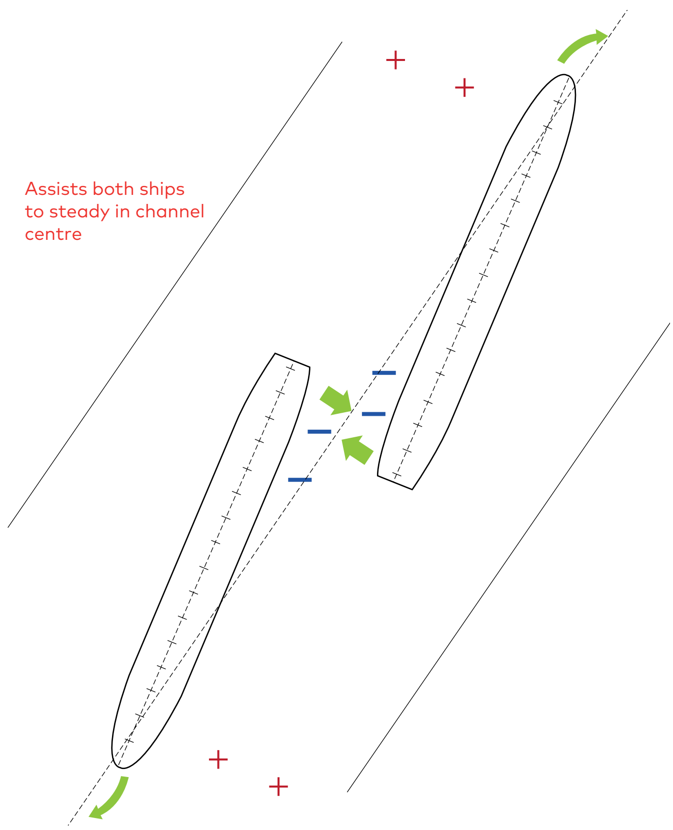


Fig. 2.24. *Passing – Phase 3 (Pluzhnikov).*

- Prior to the manoeuvre, each ship remains in the centre of the channel for as long as possible. Failure to do so could expose either ship to bank effect, leading to a sheer across the path of the oncoming ship or grounding.
- Speed should be low to reduce the interactive forces. There is then plenty of reserve power for corrective "kicks ahead".
- If the ships pass from deep to shallow water, at any time during the manoeuvre, the forces will increase drastically and extreme caution should be exercised.
- The smaller of the two ships and tugs are likely to be the most seriously affected. Large ships should be aware of this and adjust their speed accordingly.
- The engines should be brought to dead slow ahead for the manoeuvre, particularly turbine or fixed pitch propeller ships, so that power is instantly available to control the ship with "kicks ahead".
- On completion of the manoeuvre, each ship should regain the centre of the channel as quickly as possible to avoid any furtherance of bank effect.

The ship to be overtaken should not move over to the starboard side without first considering the consequences of bank effect and the danger of shearing across the path of the overtaking vessel. This particularly applies to smaller vessels, which will be easily influenced by a larger ship.

As Ship A approaches the stern of Ship B, its bow pressure zone will put pressure on the rudder of Ship B causing it to shear across the path of the overtaking vessel. The overtaking Ship A will also feel the low pressure area astern of B and exhibit a tendency to turn in towards the stern of the other ship. Ship B may experience an increase in speed, as it is virtually pushed along by the pressure zone of the overtaking ship.

These can be very powerful forces, and it may require full rudder and power to counteract them!

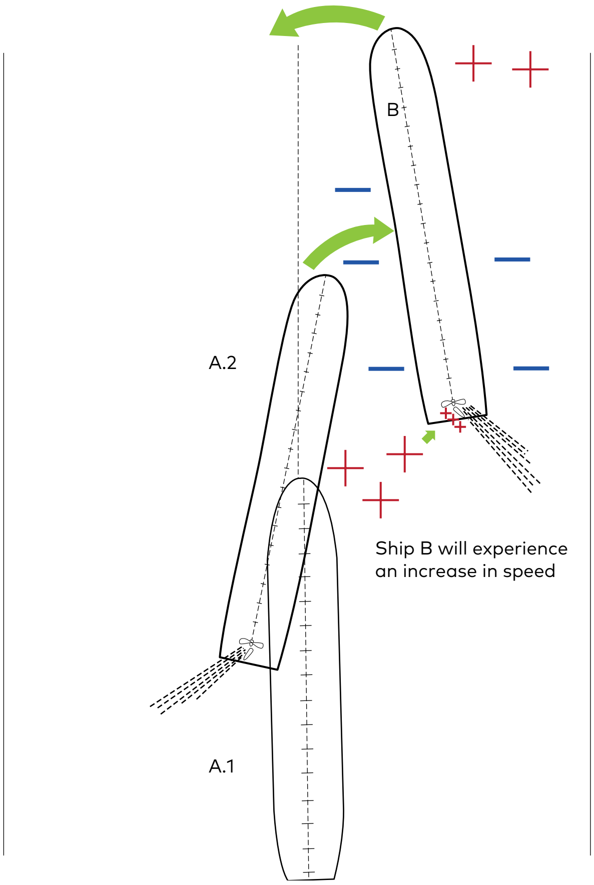


Fig. 2.25. *Overtaking – Phase 1 (Pluzhnikov).*

With two ships abeam of each other, a powerful pressure zone exists between their bows and a low pressure area between their sterns. These combine to produce a strong turning lever, which is trying to swing the bows away from each other. This is a powerful force and vigorous corrective measures may again be needed.

In addition to the turning force, there is also an underlying suction area between the two ships which will, if they are allowed to get too close, draw them

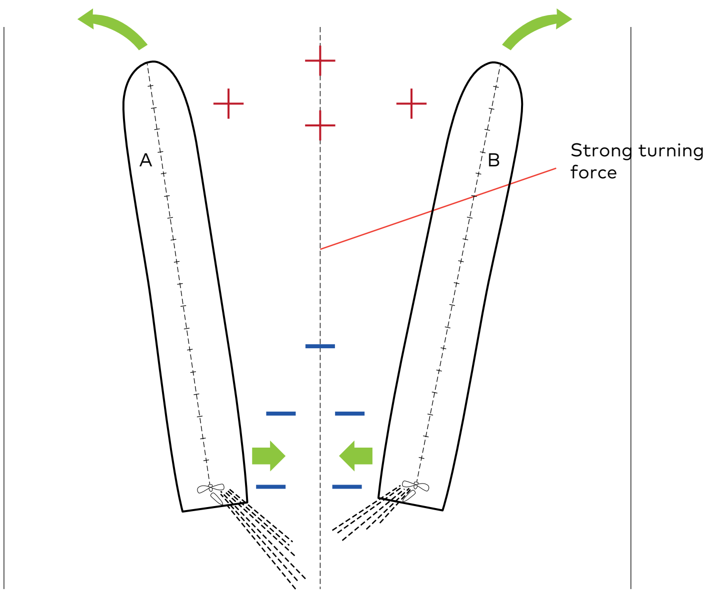


Fig. 2.26. *Overtaking – Phase 2 (Pluzhnikov).*

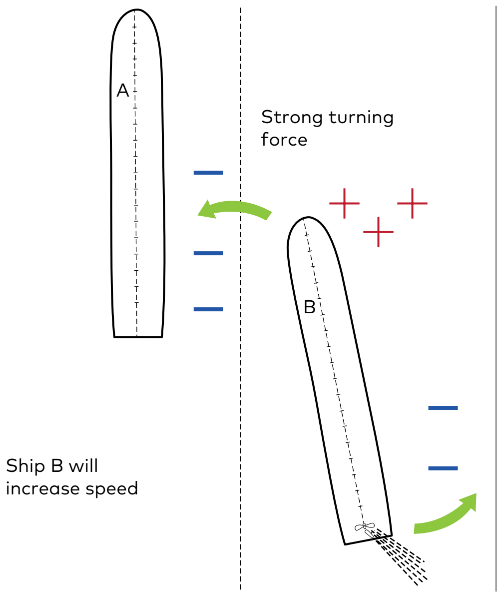


Fig. 2.27. *Overtaking - Phase 3 (Pluzhnikov).*

inexorably alongside of each other. If this does happen, Ship B is normally dragged along with ship A, and unless they both slow down together to relax the suction area between them, it is especially difficult to get the two ships apart again.

At this stage, Ship B may revert to its original propeller speed and appear to slow down in relation to the other vessel. As the overtaking ship passes to other vessel, Ship B may be influenced by the effects of two powerful forces. Firstly, on one side, bank effect, and secondly, on the other side, the low pressure area of the passing vessel. This can combine as a very strong turning force and require bold corrective action.

The rudder of Ship A may be adversely effected with positive pressure, as it passes through the pressure zone around the bow of the overtaken Ship B, particularly if that ship is large. This can cause Ship A to turn unexpectedly across the path of the overtaken ship. As Ship B is drawn towards the suction area of the passing ship, it may experience a noticeable increase in speed.

2.8. THE EFFECT OF WIND

The ship handler faces many problems but there is none more frequently experienced and less understood than the effect of wind. All too often when slowing down after a river passage, whilst entering locks and during berthing, it can create a major difficulty. With or without tugs, if the problem has not been thought out in advance, or if it is not understood how the ship will behave in the wind, the operation can get out of control extremely quickly. Needless to say, with no tug assistance, it is wise to get this area of ship handling right first time and also appreciate what the limits are.

It is frequently stated by many a master that “the large funnel right aft, acts like a huge sail”. Whilst this is to some extent true, it simply does not explain everything satisfactorily. It is important to look at the problem more closely.

2.8.1. Vessel stopped

We have a ship on even keel, stopped dead in the water. It has the familiar all aft accommodation and we will assume at this stage that the wind is roughly on the beam. Whilst the large area of superstructure and funnel offer a

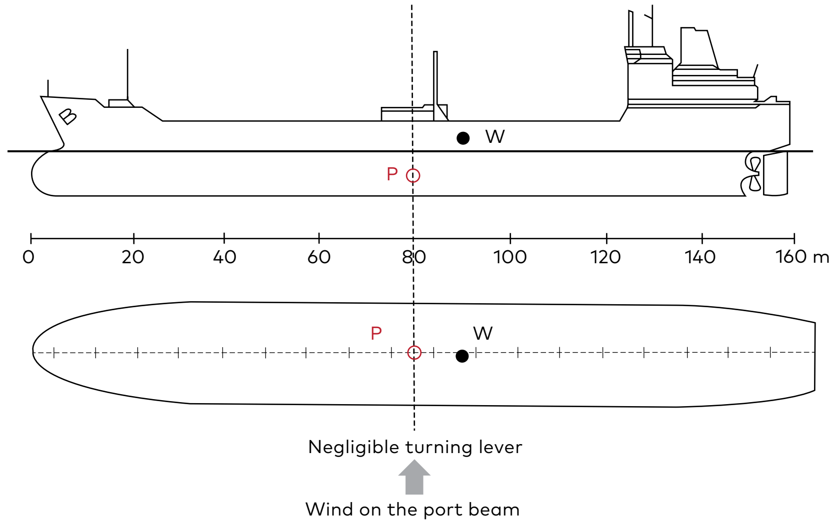


Fig. 2.28. *Vessel stopped (Pluzhnikov).*

considerable cross section to the wind, it is also necessary to take into account the area of freeboard from forward of the bridge to the bow. On a VLCC (Very Large Crude Carrier) this could be an area as long as 250 × 10 metres.

The centre of effort of the wind (W) is thus acting upon the combination of these two areas and is much further forward than is sometimes expected. This now needs to be compared with the underwater profile of the ship and the position of the pivot point (P), as discussed previously. With the ship initially stopped in the water, this was seen to be close to amidships. The centre of effort of the wind (W) and the pivot point (P) are thus quite close together and therefore do not create a turning influence upon the ship. Although it will vary slightly from ship to ship, generally speaking, most will lay stopped with the wind just forward or just abaft the beam.

2.8.2. Vessel making headway

When the same ship is making headway, the shift of the pivot point upsets the previous balance attained whilst stopped. With the wind on the beam, the centre of effort of the wind remains where it is but the pivot point moves forward. This creates a substantial turning lever between P and W and, depending on wind strength, the ship will develop a swing of the bow into the wind.

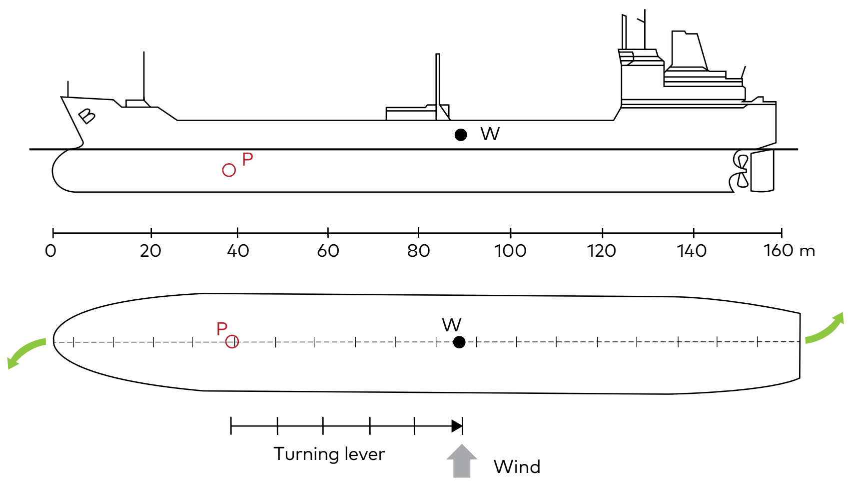


Fig. 2.29. *Vessel making headway (Pluzhnikov).*

This trend is compounded by the fact that at lower speeds the pivot point shifts even further forward, thereby improving the wind's turning lever and effect. It is a regrettable fact of life that, when approaching a berth with the wind upon or abaft, and with a reduced speed, the effect of the wind gets progressively greater; that requires considerable corrective action.

When approaching a berth or a buoy with the wind dead ahead and the ship on an even keel, such an approach should be easily controlled. Even at very low speeds the ship is stable and will wish to stay with the wind ahead until stopped.

2.8.3. Vessel making sternway

The effect of the wind on a ship making sternway is generally more complex and less predictable. In part this is due to the additional complication of transverse thrust when associated with single screw ships. Remaining with the same ship, we have already seen that with sternway the pivot point moves aft to a position approximately 1/4 L from the stern. Assuming that the centre of effort (W) remains in the same position, with the wind still on the beam, the shift of pivot point (P) has now created a totally different turning lever (WP). This will now encourage the bow to fall off the wind when the ship is backing, or put another way, the stern seeks the wind.

Some caution is necessary, however, as the turning lever can be quite small and the effect disappointing, particularly on even keel. In such cases the stern may only partially seek the wind, with the ship making sternway "flopped" across the wind. This situation is not helped by the centre of effort (W) moving aft as the wind comes round onto the quarter. This in turn tends to reduce the magnitude of the turning lever WP.

The other complicating factor is transverse thrust. If the wind is on the port beam, there is every likelihood that transverse thrust and effect of wind will combine and indeed take the stern smartly into the wind. If, however, the wind is on the starboard beam, it can be seen that transverse thrust and effect of wind oppose each other. Which force wins the day is therefore very much dependent upon wind strength versus stern power, unless you know the ship exceptionally well, there may be no guarantee as to which way the stern will swing when backing.

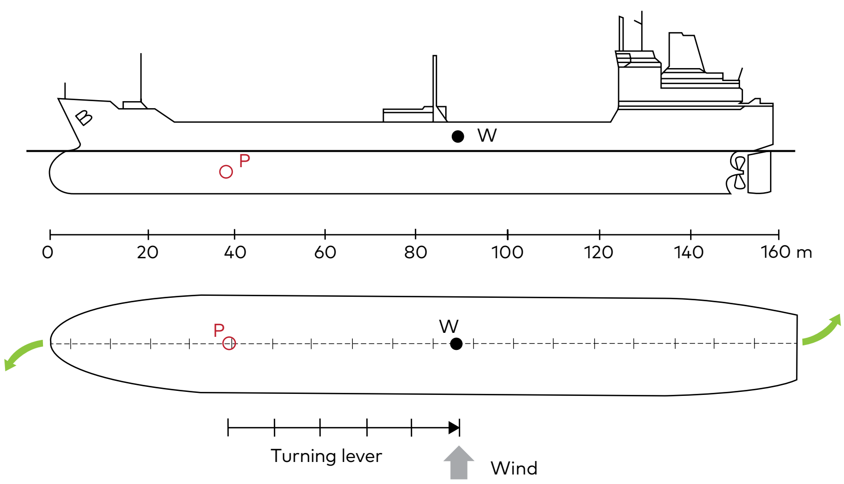


Fig. 2.30. *Vessel making sternway (Pluzhnikov).*

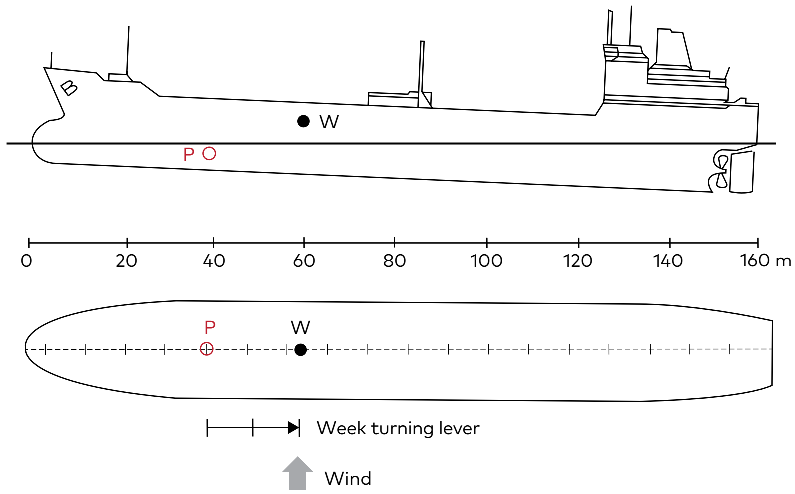


Fig. 2.31. *Stern trim and headway (Pluzhnikov).*

2.8.4. Trim and headway

So far we have only considered a ship on even keel. A large trim by the stern may change the ship's wind handling characteristics quite substantially. Figure 2.31 shows the same ship, but this time in ballast and trimmed by the stern. The increase in freeboard forward has moved W forward and very close to P. With the turning lever thus reduced, the ship is not so inclined to run up into the wind with headway, preferring instead to fall off, or lay across the wind. Because the ship is difficult to be kept head to wind, some pilotage districts will not accept a ship that has an excessive trim by the stern, particularly with regards to SBM operations.

2.8.5. Trim and sternway

The performance when going astern is also seriously altered. With the wind on the beam and W well forward, the turning lever WP is consequently increased. Once the ship is stopped, and particularly when going astern, the bow will immediately want to fall off the wind, often with great rapidity while the stern quickly seeks the wind.

When berthing with strong cross winds, or attempting to stop and hold in a narrow channel, it is best to plan well ahead as such a ship can prove

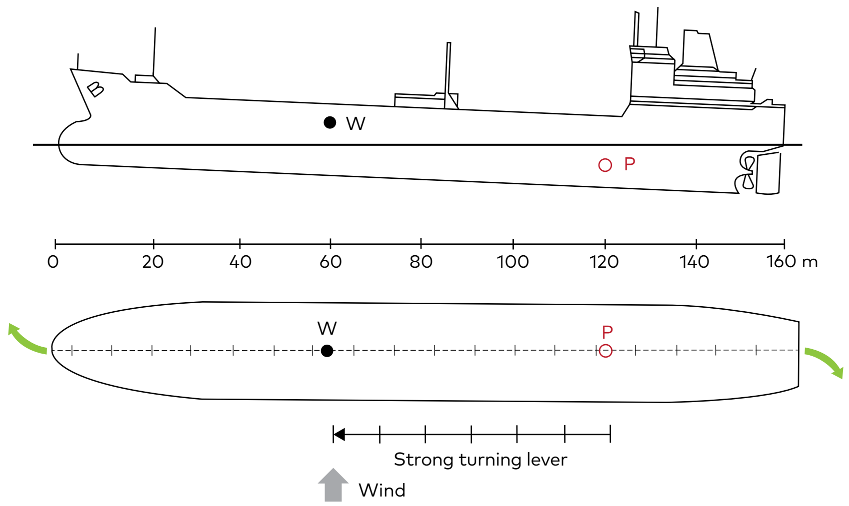


Fig. 2.32. *Stern trim and stern way (Pluzhnikov).*

very difficult to be held in position. However, as long as we have some prior knowledge as to how the ship will react to the influence of the wind, it can be turned to advantage and readily employed to aid rather than hinder ship handling. Not for nothing is it often referred to as a “poor man’s tug!”

2.8.6. Vessel head to wind with headway

A vessel is making headway through the water, and heading directly into the wind. W is now well forward of amidships, and in fact very close to P; the wind is exerting no turning moment or sideways force on the vessel. A comparatively small change in relative wind direction (either by alteration of course, or wind fluctuation) will place the wind on the vessel’s bow; the whole of one side of the vessel will now be exposed to the wind, and W will move aft as shown in the side diagrams.

The following effects will now be experienced:

a) the turning force will now develop a turning moment about P, tending to turn the vessel into the wind again;

b) the wind force will also develop a sideways force on the vessel, away from the exposed side.

Therefore, head to wind vessel is “course stable”, provided that she maintains headway through the water. If the ship has a large trim by the stern, W will be further forward, with a reduction or even loss of “course stability”. This can sometimes result in a rapid and violent loss of control.

2.8.7. Vessel head to wind with sternway

Consider the situation when our vessel remains head to wind, but now starts to make sternway through the water. W remains forward, whilst P has moved aft, as shown in the middle diagram of Fig. 2.34 the wind is exerting no turning moment, or sideways force.

A comparatively small change in the relative direction of the wind will move W aft, as shown in the side diagram of Fig. 2.34, however P remains aft of W.

The following effects will now be experienced:

a) the wind force will develop a strong turning moment about P, tending to turn the vessel’s bow further away from the wind;

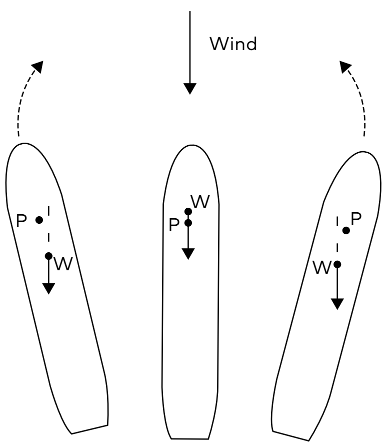


Fig. 2.33. *Headway with wind ahead - on even keel (Pluzhnikov).*

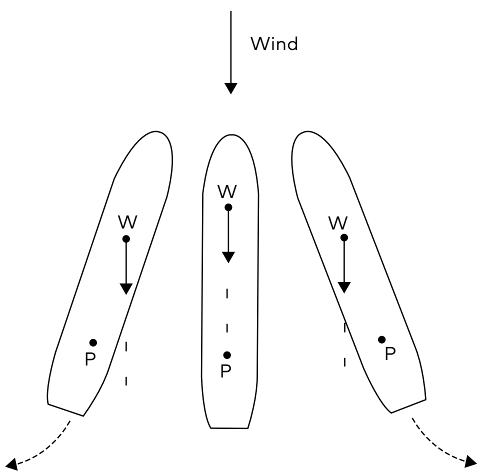


Fig. 2.34. *Sternway with wind ahead – on even keel (Pluzhnikov).*

b) the wind force will develop a sideways force on the vessel, away from the exposed side;

While on head to wind, as soon as the vessel starts to make sternway through the water, she loses "course stability" and the bow will turn away from the wind, sometimes quite rapidly. If the ship has a large trim by the stern, W may move further forward, perhaps quickly, and the loss of "course stability" is even more pronounced. This can sometimes result in a rapid and violent loss of control.

2.8.8. Vessel stern to wind making headway

When a vessel is making headway through the water with the wind directly astern, P moves forward, a long distance from W, which is well aft. A comparatively small change in relative wind direction will move W forwards as shown in the side diagrams of Fig. 2.35, however W is still some distance abaft P.

The following effects will now be experienced:

a) the wind force will develop a strong turning moment around P, tending to turn the vessel's stern further away from the wind;

b) the wind force will develop a sideways force on the vessel, away from the exposed side.

Making headway with stern to wind, the vessel loses "course stability" and is difficult to steer, this effect is greater when there is also a following sea or swell.

If the ship has a large trim by the stern, W may move further forward, and loss of "course stability" may be generally less pronounced, but still a potential danger.

2.8.9. Vessel stern to wind making sternway

When a vessel is making sternway through the water with the wind directly astern, P moves aft, fairly close to W, which remains even further aft. A change in relative wind direction will eventually move W forward from P, as shown in the side diagrams of Fig. 2.36, with the following effects:

a) the wind force will develop a turning moment around P, tending to turn the vessel's stern back into the wind;

b) the wind force will develop a sideways force on the vessel, away from the exposed side.

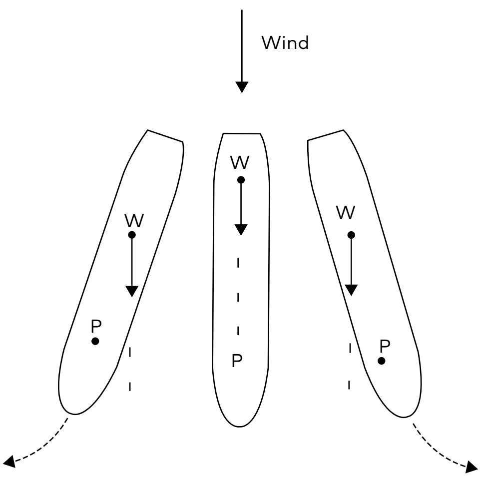


Fig. 2.35. *Headway with wind astern – on even keel (Pluzhnikov).*

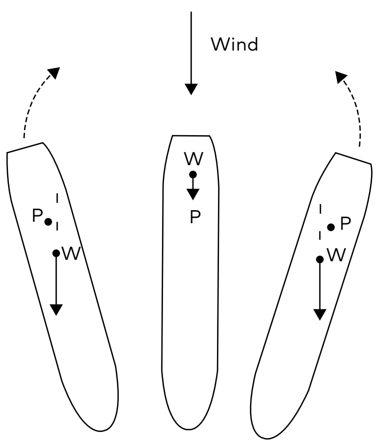


Fig. 2.36. *Sternway with wind astern – on even keel (Pluzhnikov).*

Making sternway through the water, with stern to wind, the vessel is again "course stable". If the ship has a large trim by the stern, W may move further forward, generally improving "course stability"; however with such a trim there is always the possibility of unpredictable loss of control.

Whilst complicated formulae do exist for calculating the force of wind upon a ship, it would be more practical to have at hand a relatively simple method of achieving a working figure. The first requirement is to obtain the best available estimation of the area of the ship presented to the wind in square metres. This can be as simple as the following formula:

overall length (m) × max. freeboard (m) = windage area (m^2). (2.4)

An approximate wind force in tonnes per 1,000 m^2 can then be calculated using the following formula:

If V = wind speed (metres / second) = wind speed (knots) ÷2, then (2.5)
force (tonnes) per 1000 m2 = V2 ÷ 18

It should be noted that the wind force varies as the square of the wind speed.

Small increases in wind speed can mean large increases in wind strength, especially in stronger winds, when gusting can place an enormous strain on the ship.

Using the above formulae, this is illustrated with the graphs of wind force (tonnes) over a wide range of wind speeds (knots) for the tanker and the large car carrier.

2.9. ANCHORING

2.9.1. The anchor plan

An anchor plan should be established between the interested parties, namely: the ship's Master, the Officer in Charge (OiC) of the anchor party, or the Master of Anchor Handling Vessel (AHV). It would be expected that these key personnel would inform relevant crew members through an established chain of command

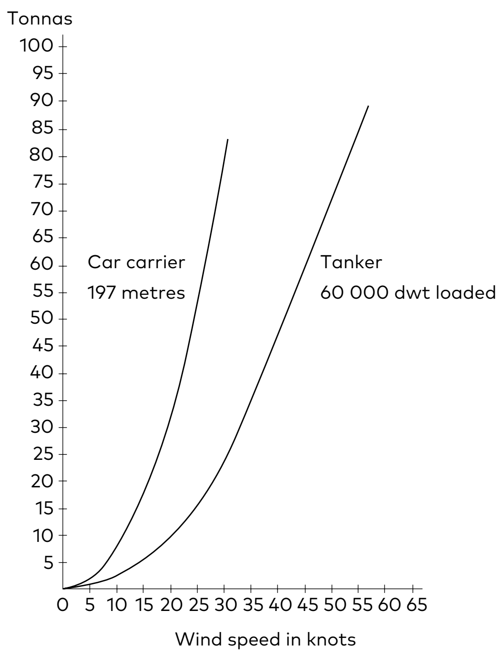


Fig. 2.37. *The effect of wind quantified (Pluzhnikov).*

regarding relevant criteria. In the construction of any anchor plan the following items must be worthy of consideration:

1. the intended position of anchoring of the vessel;
2. the available swinging room at the intended position;
3. the depth of water at the position, at both high and low water times;
4. the defined position is clear of through traffic;
5. a reasonable degree of shelter is provided at the intended position;
6. the holding ground for the anchor is good and will not lead to "dragging";
7. the position as charted is free of any underwater obstructions;
8. the greatest rate of current in the intended area of the anchorage;
9. the arrival draught of the vessel in comparison with the lowest depth ensures adequate underkeel clearance;
10. the choice of anchor(s) to be used;
11. whether to go for "single anchor" or an alternative mooring;
12. the position of the anchor at point of release;
13. the amount of cable to pay out (scope based on several variables);
14. the ship's course of approach towards the anchorage position;
15. the ship's speed of approach towards the anchorage position;
16. defined positions of stopping engines, and operating astern propulsion (single anchor operation);
17. position monitoring systems confirmed;
18. state of tide ebb/flood determined for the time of anchoring;
19. weather forecast obtained prior to closing the anchorage;
20. time needed to engage manual steering established.

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

NB. Important!

Masters, or officers in charge, should consider that taking the vessel into an anchorage must be considered a bridge team operation.

2.9.2. Bringing the vessel to a single anchor

It is a normal procedure for a ship's Master to consider the approach towards an anchorage, and discuss the operation with the officer in charge of the anchor party, namely the Chief Officer of the vessel. Probably the most common of all uses of anchors is to bring a vessel into what is known as a "single anchor" where the ship has adequate swinging room to turn about her one anchor position, with the turn of the tide and / or influence of the prevailing weather.

A planned approach to the intended position should be employed with the Master or Marine Pilot holding the "con" of the vessel. The anchor party, on the orders of the Master, should clear away the anchor lashings and "walk back" the intended anchor for use in ample time, before the vessel reaches the anchor position. The readiness of the anchor to be "let go" should be communicated to the bridge by the intercom / phone system or walkie-talkie radio.

The Master would turn the vessel into a position of stemming the tide and manoeuvre the ship towards that position (as per plan) where he intends to let go the anchor. By necessity, the ship will still be making "headway" in order to attain this position. Headway is taken off at this point by using astern propulsion but it will be noticed that sternway will not take an immediate effect (the Master will have to estimate when the vessel is moving astern and this is not always readily observed. One method is to sight the wake from the propeller moving past the midships point towards the forward part of the vessel. This is a positive indication of vessel being on sternway).

A fundamental principle of anchoring is that it is the weight of cable and the lay of the "scope" that anchors the vessel successfully, not just the weight or design of the anchor.

Once sternway is positively identified on the vessel, and the position of letting go the anchor is achieved, the Master orders the anchor to be released. The astern movement of engines is reduced to an amount that the anchor cable could be payed out on the windlass brake, as the vessel continues to drop astern, slowly. The officer in charge of the anchor party checks the run of cable by using the gypsy braking system in order to achieve a lay of cable length along the seabed. The officer in charge endeavours not to pile the cable in a heap on top of anchor, or close to the anchor position. As the pre-determined amount of cable to be released is achieved, the engines should be stopped from moving astern. The cable has to be allowed to run and the brake should then be applied to check the amount of scope. This should serve the purpose of digging the anchor into the seabed and stop the vessel from moving any further astern, over the ground. The ship is described as being "brought up" to her anchor and it is the duty of the Anchor Party Officer to determine when the vessel is "brought up" and not dragging her anchor.

2.9.3. Swinging room – vessel lying to a single anchor

Swinging room for a vessel at the single anchor will occur at the maximum scope of cable when at long stay. This circle of swing could be practically reduced by employing two anchors in the form of either a running or standing moor. Although these moorings are not generally common, they are suitable when a large swinging circle is not permitted, like within a canal or river where sea room is restricted.

The vessel will swing through 180° with each turn of the tide (usually about every 6 hours). Movement of the vessel at anchor will also be influenced by the direction of wind. It is significant that wind over tide produces a powerful effect on the cable and, depending on the nature of the holding ground, may cause the anchor to break out and allow the vessel to drag her anchor, which is an extremely undesirable situation.

Watch Officers should be cautious about any traffic movement within the circle of swing, especially of traffic attempting to cross the ship's bow. Such traffic would be directly affected by the same direction of tide / current and be caused to set down on the anchor cable.

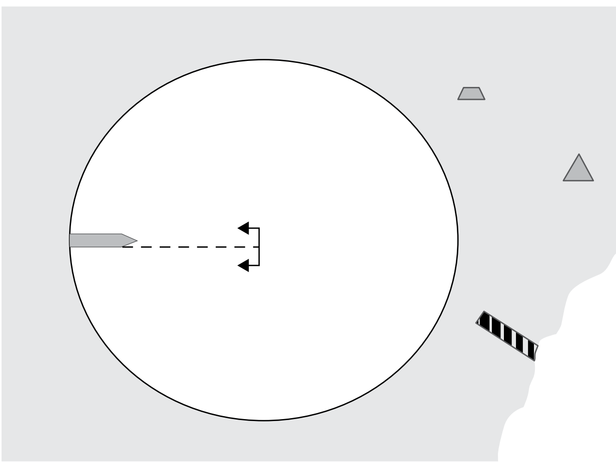


Fig. 2.38. *Swinging room for a vessel at the single anchor (D. J. House).*

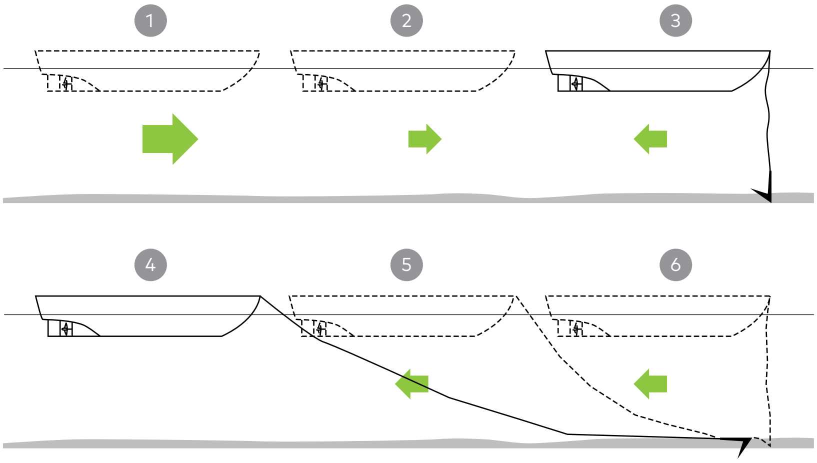


Fig. 2.39. *Maneuvring when anchoring (D. J. House).*

2.9.4. Manoeuvres

1. At the final stage of the approach, stop the engine. Allow the vessel to glide into the intended area.
2. Engine astern (to stop the vessel).
3. Stop Engine. Allow the vessel to drift astern very slowly.
4. Let go anchor. Once the anchor reaches the bottom, keep some weight on the anchor line and ease it out slowly as the vessel moves astern (this helps stretch the anchor chain out on the sea bottom instead of gathering in a heap).
5. Allow the vessel to drift with the tide or down wind or till the required length of anchor line is paid out, using the engine if necessary.
6. When the correct length of anchor line is paid out, secure the line to a suitable strong point on the vessel.

2.9.5. Weighing anchor

- Check the direction in which the anchor line leads.
- Start the engine.
- Brief the crew.
- Clear the working deck of obstructions.
- Commence hauling-in the anchor line.
- If the anchor line is too taut to haul-in, use the engine as necessary to manoeuvre the vessel ahead slowly to take the weight off the anchor line.
- Upon weighing anchor, ensure all anchor gear is stowed away properly quickly and the anchor is properly lashed in order to safely proceed to sea.

2.9.6. Turning short round (right hand fixed propeller)

Alter the ship's head to move to the port side of the channel, as this would gain the greatest advantage when operating astern from transverse thrust during the turn.

1. Dead slow ahead on engines and order the helm hard to starboard.
2. Stop engines, wheel midships.
3. Vessel is still moving ahead making headreach.

Full astern, wheel amidships, until the vessel gathers sternway, then stop engines. The effect of transverse thrust generates a tendency for the bow to move to starboard and the stern to move to port (with the ships bow in the

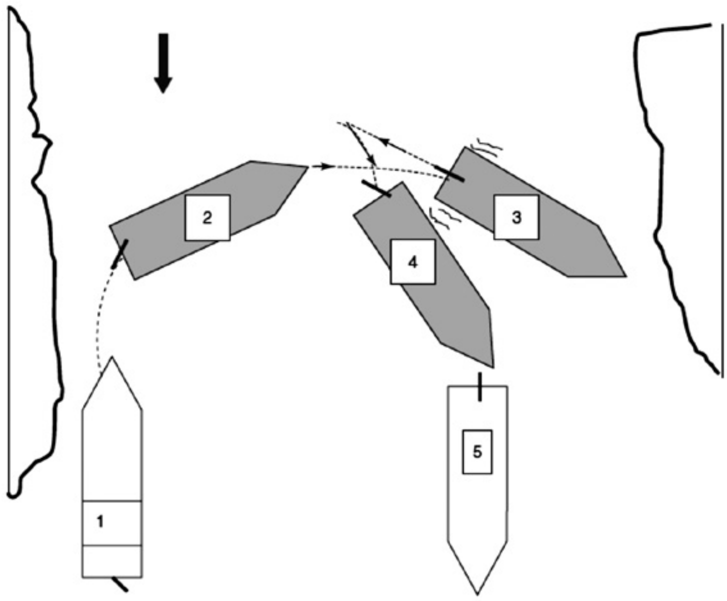


Fig. 2.40. *Turn in a narrow channel (D. J. House).*

centre of the channel, where the flow is the strongest, the tide effect tends to push the bow round to starboard).

4. & 5. Wheel hard to starboard, engines full ahead to achieve the reverse heading.

The objective of turning short round is to effect a tight turn within the ship's own length or as near as possible to within its own length.

2.10 BERTHING AND UNBERTHING

2.10.1. Berthing port side to the quay – right hand fixed propeller – calm conditions

1. Approach the berth at an angle of about 25°, engines dead slow ahead.
2. Stop engines on the approach taking account of the headway that the vessel will carry.
3. Engines astern. Transverse thrust would cause the stern to swing to port and the ship would gradually stop parallel to the berth.
4. Stop engines. Send away head and stern lines and make fast.

NB. Important!

If the angle of approach is larger than suggested, it may be necessary to use a small amount of starboard helm in position "3" in order to start the stern swing in towards the quay. Excessive helm use would generate a too fast stern swing.

Astern movement of engines will cause transverse thrust to swing the stern towards the quay.

2.10.2. Berthing starboard side to quay – right hand fixed propeller – calm conditions

1. Approach the quay at a shallow angle, say at about 15°, engines dead slow ahead.

Stop engines on approach taking account of the headway, which the ship will carry.

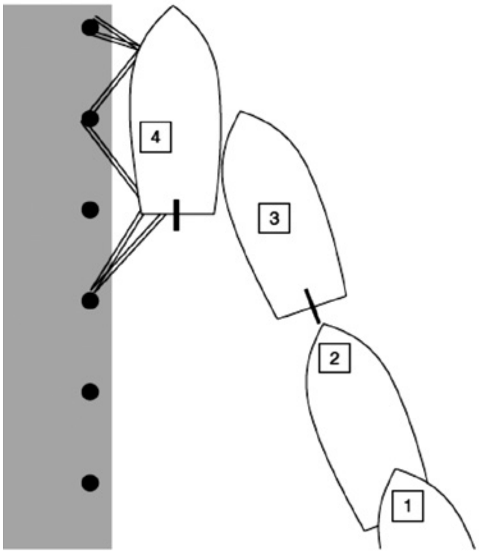


Fig. 2.41. *Berthing port side to the quay (D. J. House).*

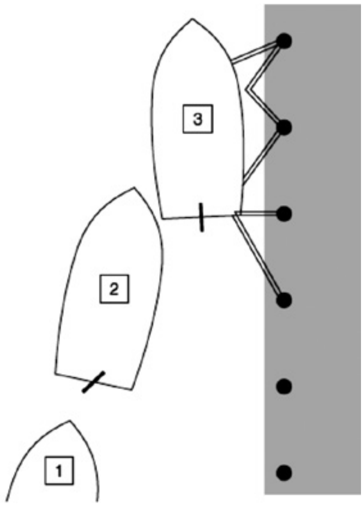


Fig. 2.42. *Berthing starboard side to quay (D. J. House).*

2. When approaching the berth, apply port helm to cause the stern to swing towards the berth. Engines astern to stop the ship and the effects of transverse thrust will check the stern swing.
3. Stop engines. Send away head and stern lines and make fast.

NB. Important!

In the event that there is limited room ahead of the vessel, the forward spring line should be sent first.

2.10.3. Berthing into strong offshore wind – slack water conditions

1. Approach the berth at a steep angle to reduce the windage effect on the vessel.
2. Prepare a stern line to be passed from the forward position (assuming no mooring boat is available). Approach the berth at a dead slow ahead speed.

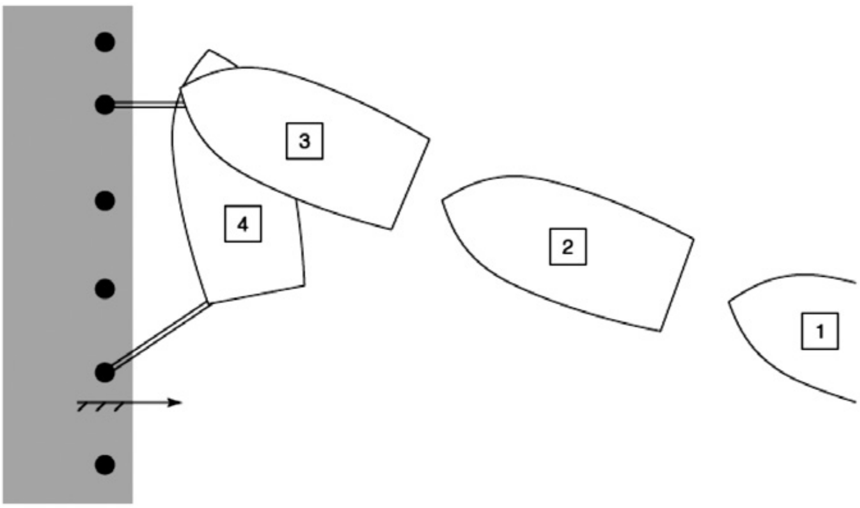


Fig. 2.43. *Berthing into strong offshore wind – slack water conditions (D. J. House).*

3. Stop engines, on approach, then engines astern to stop the bow just off the berth.

Pass a head line to the quay using a heaving line from the wharf, rather than the ship's heaving line, to gain benefit of wind.

4. Pass the stern line from the forward position and carry the mooring up the quay.

Ease the head line and heave on the stern line to bring the vessel alongside.

Comment: A mooring boat employed to carry the stern line ashore eliminates the need to pass the stern mooring forward.

Once alongside, breast ropes fore and aft would reduce the possibility of the vessel being blown off the quayside.

2.10.4. Berthing port side to, with a strong onshore wind

1. Stem the tide at position "1" rudder hard to starboard and engines half ahead.
2. Attain a position off the berth and parallel to the berth, with the port side well fendered (possible use of the offshore starboard anchor may be desirable for departing the berth with the same direction of wind).
3. High freeboard vessels will benefit from the wind on the beam and allow the vessel to close the berth at position "3". Run head lines and stern lines fore and aft.
4. As the vessel lands alongside the quay, pass and secure fore and aft springs and adjust the ship's position to suit with head and stern lines. Once secure, if the offshore anchor has been deployed, walk back the cable to an up and down position.

NB. Important!

The use of the offshore anchor can clearly check the rate of approach of the bow, but the use of engines and rudder against the angled direction of the anchor cable may be needed to keep the stern parallel to the quayside and ease the landing.

Leaving the cable in the up and down position is to avoid the chain obstructing the channel for passing traffic, while at the same time providing a useful means of heaving the ship off the berth against the onshore wind, when departing.

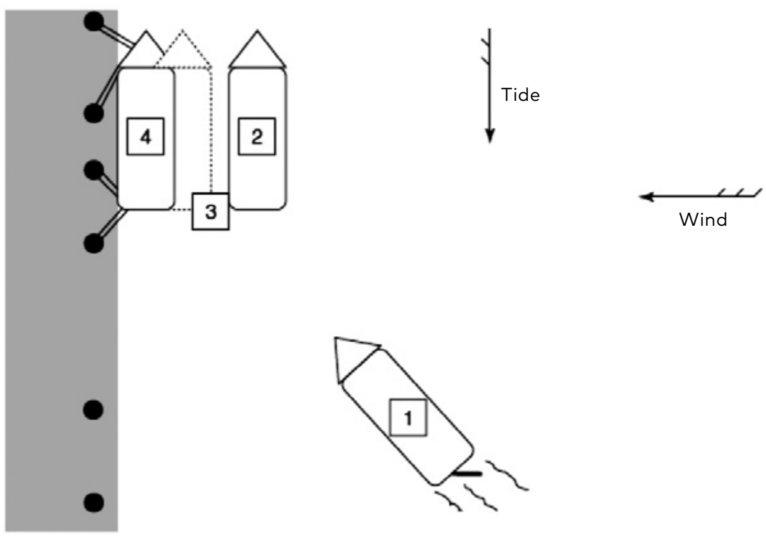


Fig. 2.44. *Berthing port side to, with a strong onshore wind (D. J. House).*

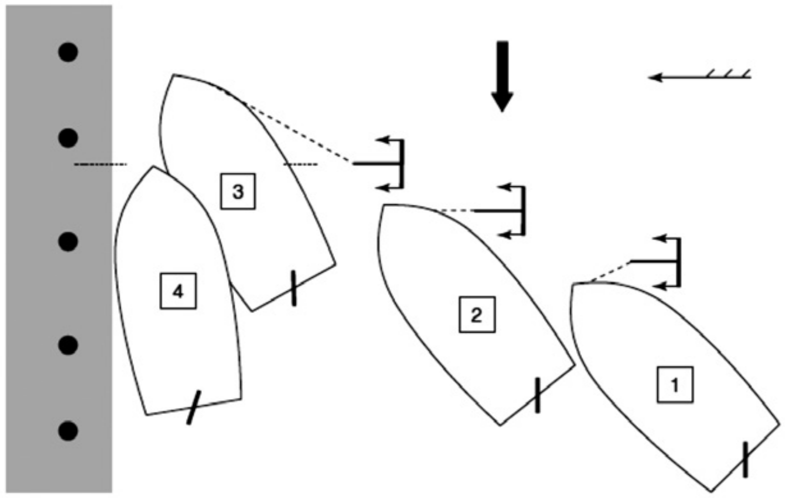


Fig. 2.45. *Berthing using an offshore anchor (D. J. House).*

2.10.5. Berthing port side to (for vessels with windage area aft) with a strong onshore wind

1. Approach the berth at about a 60° angle. Stop the vessel off the berth with the bow level with the centre of the berthing position. Let go the offshore anchor at short stay. To control the stern against the wind, use rudder to port and engines ahead. Dredge the anchor towards the berth.
2. As the vessel approaches the berth, pay out the anchor cable.
3. When the bow is just off the berth, hold on to the anchor. The vessel will pivot at the hawse pipe and the stern will swing rapidly towards the quay.
4. As the stern is approaching the quay, engines ahead to check the stern swing.

Stop engines and run lines ashore fore and aft.

2.10.6. Berthing starboard side to – tide ahead – right hand fixed propeller

1. Stem the tide and approach the berth using engines ahead to maintain position.
2. Apply a little starboard helm to cause the bow to cant towards the berth. Then steady the ship's head. The vessel could expect to move bodily towards the berth.
3. Just off the berth, bring the vessel head to tide and send away a head line with an aft spring.
4. Once alongside, stop engines and make fast with head lines, stern lines and springs.

Comment: If an offshore wind is present, the use of engines with the port helm may be necessary to cause the stern to close the quay to pass stern lines. Alternatively, a mooring boat could be employed. When an onshore wind is present, it may be necessary to ease the headline once landed, to allow the stern to close from the effects of wind and tide.

2.10.7. Unberthing – starboard side to, with offshore wind, no tide

1. Single up to head line and stern line (or breast lines).
2. Ease the head and stern lines to allow the vessel to be blown off the quay. When the stern is clear of the quay, hold on to the aft line and allow the bow to come off the quay a little more.

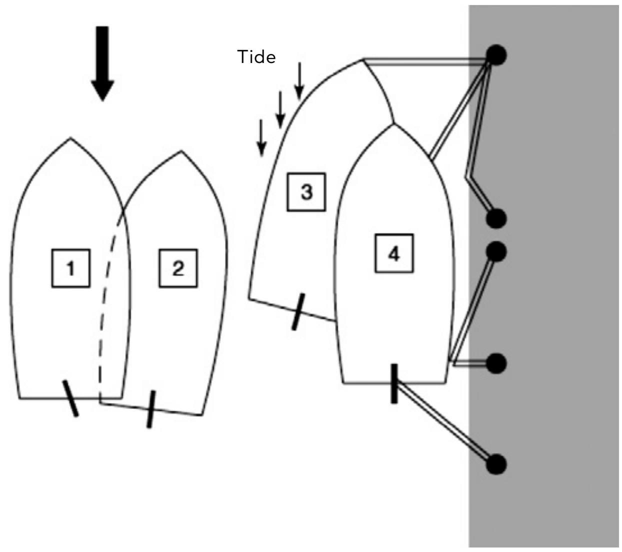


Fig. 2.46. *Berthing starboard side to – tide ahead (D. J. House.)*

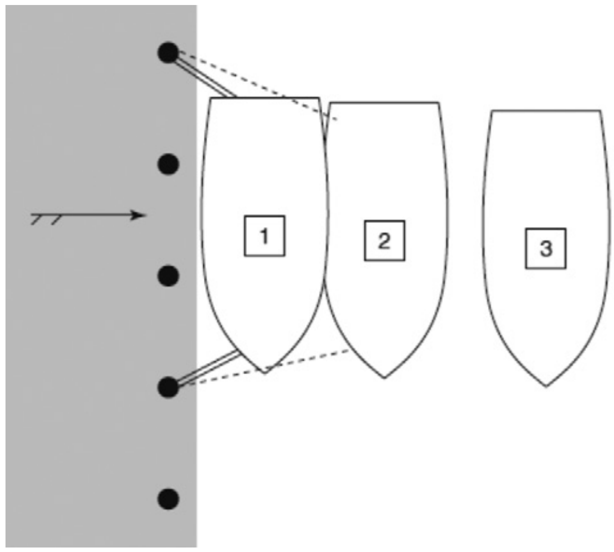


Fig. 2.47. *Unberthing – starboard side to, with offshore wind, no tide (D. J. House).*

3. Once clear of the quayside, let go bow and stern lines and engage engines and helm.

Comment: This method is recommended for high-sided vessels like car carriers and Ro–Ro-s, which have their superstructure exposed over and above the quay height.

Deep laden vessels with low superstructure may have to use a double spring mooring forward and spring the stern of the vessel off the quay into deeper water.

2.10.8. Unberthing – port side to, tide ahead, no wind

The objective is to clear the berth when a tidal stream is ahead of the vessel. The action allows a wedge of water to flow between the dock wall and the ship's side so forcing the vessel off the berth.

1. The vessel should be singled up to a head line, and an aft spring.
2. The aft spring line should initially be kept tight, while the head line is slacked down. The tidal stream effect would pivot the vessel about the spring and cause the bow to move off the berth. The weight of stream water moving between the berth and the ship's side, forces the stern a little away from the dock.
3. Dead slow ahead on engines and let go forward. Stop engines and let go aft.
4. Engines ahead to clear the berth into the tidal stream.

2.10.9. Unberthing – starboard side to, no wind and slack water conditions

The objective is to clear the berth and take the vessel into deep water. Where slack water conditions prevail, an alternative method for using the tidal/stream flow must be employed to manoeuvre the vessel clear of the berth. The prudent use of mooring lines can achieve initial movement of the vessel, so that the propeller can be utilized.

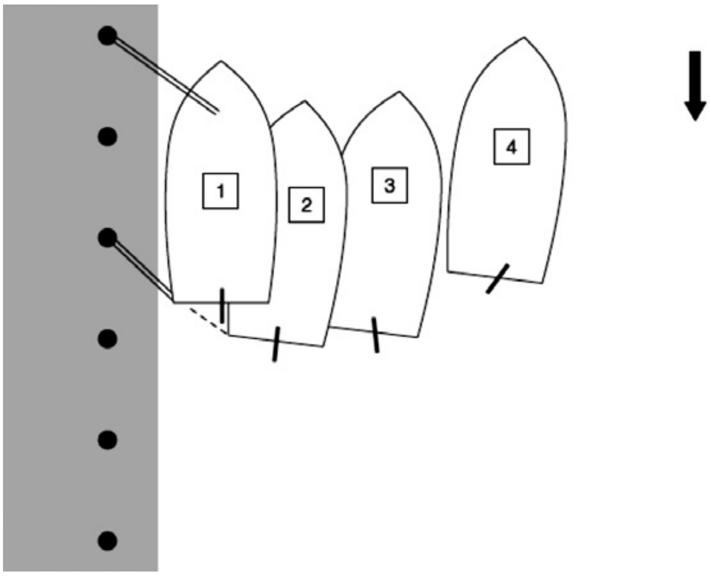


Fig. 2.48. *Unberthing – port side to, tide ahead, no wind (D. J. House).*

2.10.10. Assuming a right hand fixed propeller

1. Single up to a forward spring and an offshore headline. Let all lines go aft.
2. Heave on the offshore headline to tension the spring and place engines at dead slow ahead. The stern would be expected to turn outwards away from the berth.
3. Once the stern is angled away from the berth, place rudder amidships and let go the head line. Operate astern propulsion and as the vessel comes astern the spring goes slack and can be let go.
4. As all lines are cleared, the vessel increases astern propulsion with rudder amidships. The effect of transverse thrust will cause the stern to move to port.

2.10.11. Unberthing – port side to, no wind and slack water conditions

The objective is to clear the berth and take the vessel into clear water where the initial effects of transverse thrust would compromise the use of the right hand fixed propeller.

1. The vessel should be singled up to an offshore head line and the forward spring (the spring could be doubled up for this manoeuvre).

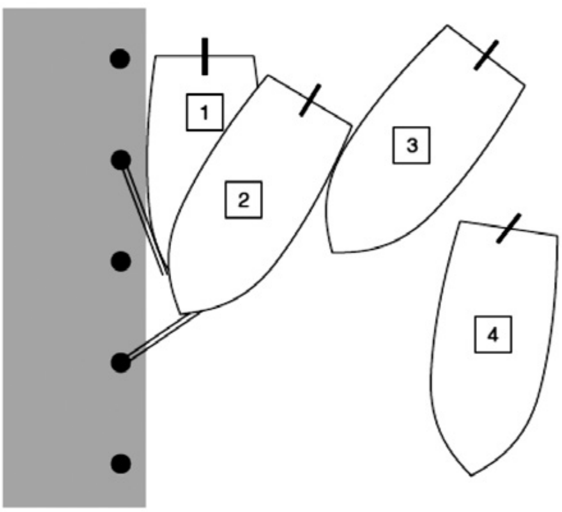


Fig. 2.49. *Unberthing – starboard side to, no wind and slack water conditions (D. J. House).*

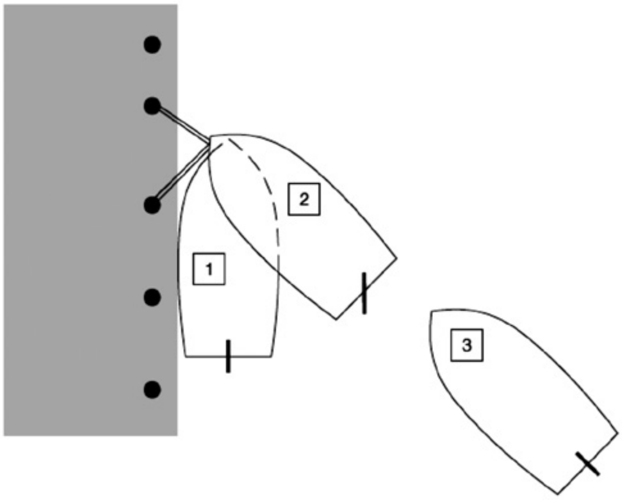


Fig. 2.50. *Unberthing – port side to, no wind and slack water conditions (D. J. House).*

2. Heave on the offshore head line to tension the spring and go dead slow ahead on engines. This action should cause the stern to move outward to starboard clear of the berth.
3. Once the stern is angled away from the berth, let go the head line and forward spring. As the lines are cleared, place the rudder amidships and the engines half or full astern. Such action would cause the transverse thrust effect to turn the vessel parallel to the berth. This would place the propeller in deep water and permit the unobstructed manoeuvring of the vessel.

2.10.12. Unberthing – tide astern – starboard side to

1. Single up to a forward spring and a stern line.
2. Ease stern line to tension the spring. The vessel will pivot on the spring and the stern will come off the quay.
3. Once the stern is clear of the quay, engines astern and let go forward. Stop engines and let go aft.
4. Rudder amidships, full astern into deeper water.

Comment: The transverse thrust of the engines when going astern would cause the stern of the vessel to come further off the quay into deeper water, prior to proceeding up or down river.

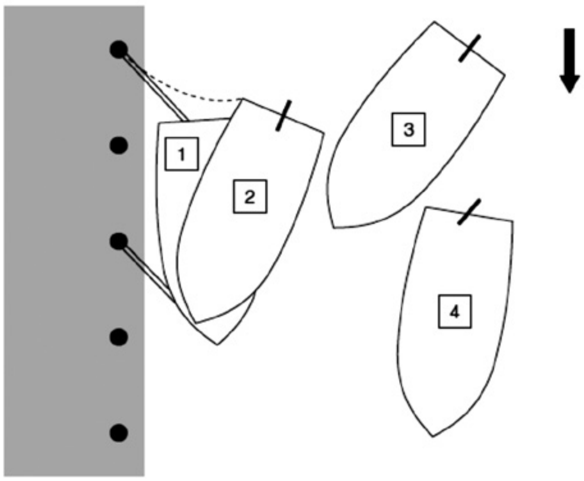


Fig. 2.51. *Unberthing – tide astern – starboard side to (D. J. House).*

EXERCISES – THE SCENARIO OF THE PRACTICAL TASK ON THE SIMULATOR OF THE NAVIGATIONAL BRIDGE

Exercise No. 1. Wind and current effects

1. Navigation area: Gibraltar Strait approach.
2. Weather conditions: Wind 040º – 25 kts, current 260 – 4 kts.
   Flow tidal (variable). Visibility of miles of 10 m.
3. Class of ship: LNG Carrier, displacement – 95215.0 t, length – 294 m.
4. Initial data: Course – 090 °, speed – 12 kts.
5. The task purpose:
   - To carry out a turning-circle trial with given initial speed and rudder angle in loaded condition with wind and current present;
   - To describe how to carry out zig-zag manoeuvres with wind and current present;
   - To carry out a coasting stop in loaded condition with wind and current present;
   - To repeat the same manoeuvres in the ballast condition.
6. Additional data:
   - Organization of watch with the passage of Gibraltar Strait under the conditions of intensive navigation in accordance with the requirements of the Convention STCW-78/95 and COLREG;
   - The conduct, handover and relief of the watch conforms with accepted principles and procedures;
   - A proper lookout is maintained at all times and in such a way as to conform to accepted principles and procedures;
   - Responsibility for the safety of navigation is clearly defined at all times, including periods when the Master is on the bridge and while under pilotage;
   - Communication is clearly and unambiguously given and received;
   - Team member(s) share accurate understanding of current and predicted vessel state, navigation path, and external environment.

Exercise No. 2. Shallow-water effects

1. Navigation area: Entrance to the port of Rotterdam.
2. Weather conditions: Wind 320º – 10 kts, current 260˚ – 1 kts.
   Tidal current (variable). Visibility – 10 miles.
3. Class of ship: General Cargo, displacement – 5486.0 t, length – 104.8 m.
4. Initial data: Course – 130 °, speed – 0 kts.
5. The task purpose:
   - To carry out approach into the port;
   - To carry out a turning-circle trial with given initial speed and rudder angle in shallow water;
   - To carry out a coasting stop in shallow water;
   - To compare the resulting plot with that of the same manoeuvre carried out in deep water.
6. Additional data:
   - Organization of watch with the passage to the port of Rotterdam under the conditions of intensive navigation in accordance with the requirements of the Convention STCW-78/95 and COLREG.
   - The conduct, handover and relief of the watch conforms with accepted principles and procedures.
   - A proper lookout is maintained at all times and in such a way as to conform to accepted principles and procedures.
   - The frequency and extent of monitoring of traffic, the ship and the environment conform with accepted principles and procedures.
   - Responsibility for the safety of navigation is clearly defined at all times, including periods when the Master is on the bridge and while under pilotage.
   - Operations are planned and resources are allocated as needed in correct priority to perform necessary tasks.

Exercise No. 3. Bank, channel and interaction effects

1. Navigation area: Entrance to the port of Rotterdam.
2. Weather conditions: Wind 320º – 10 kts, current 260˚ – 1 kts.
   Tidal current (variable). Visibility – 10 miles.
3. Class of ship: Container vessel, displacement – 18600.0 t, length – 150 m.
4. Initial data: Course – 120 °, speed – 0 kts.
5. The task purpose:
   To enter the port of Rotterdam with the passage through the narrow channel in specific navigation conditions.
6. Additional data:
   - Organization of watch with the passage to the port of Rotterdam under the conditions of intensive navigation in accordance with the requirements of the STCW Code, as amended, port regulations, COLREG and good seamanship.
   - Responsibility for the safety of navigation is clearly defined at all times.
   - To prepare a complete passage plan to harbour, taking into account navigational conditions.
   - The conduct, handover and relief of the watch conforms with accepted principles and procedures.
   - A proper lookout is maintained at all times and in such a way as to conform to accepted principles and procedures.
   - The frequency and extent of monitoring of traffic, the ship and the environment conform with accepted principles and procedures.
   - Using the data of the maneuvring of the vessel and weather conditions, to prepare a plan of approach to the port, which contains the following information:
     - the approach speed for deep water and shallow water;
     - the point at which the speed is reduced;
     - speed when passing other vessels in the channel.
   - To correctly assess the situation for safe passage of the vessel in shallow water and the channel.
   - Operations are planned and resources are allocated as needed in correct priority to perform the necessary tasks.

Exercise No. 4. Anchoring

1. Navigation area: Port Dover approach.
2. Weather conditions: Wind 035º – 12 kts, current 140˚ – 1.5 kts.
   Tidal current (variable). Visibility – 10 miles.
3. Class of ship: General cargo, displacement – 5486.0 t, length – 104.8 m.
4. Initial data: Course – 000 °, speed – 0 kts.
5. The task purpose:
   - To carry out anchoring at anchorage.
   - The conduct, handover and relief of the watch conforms with accepted principles and procedures.
   - A proper record is maintained of the movements and activities relating to the navigation of the ship.
6. Additional data:
   - Organization of watch under the conditions of intensive navigation in accordance with the requirements of the Convention STCW-78/95 and COLREG.
   - To select the position to anchor in a given area.
   - Using the ship's manoeuvring data, prepare an anchoring plan, which contains the following information:
   - approach tracks and courses to steer;
   - points at which to reduce speed;
   - the position at which to reverse the engine;
   - the position to drop the anchor;
   - the number of anchor chain for the given conditions.
   - To prepare a contingency plan outlining the actions to take in the event of an engine failure or steering failure at various stages of the approach.
   - To use a checklist for readiness for anchoring.
   - Decisions are most effective for the situation.

Exercise No. 5. Mooring operations

1. Navigation area: Port Dover approach.
2. Weather conditions: Wind 0º – 13 kts, current 248˚ – 2.5 kts.
   Tidal current (variable). Visibility – 10 miles.
3. Class of ship: Container vessel, displacement – 18600.0 t, length – 150 m.
4. Initial data: Course — 000 °, speed – 0 kts.
5. The task purpose:
   To carry out entering into the port and mooring to the Terminal of the loaded container vessel without tugs in conditions at a current and wind.
6. Additional data:
   - Organization of watch with the passage to the port of Dover under the conditions of intensive navigation in accordance with the requirements of the STCW Code, as amended, port regulations, COLREG and good seamanship.
   - To prepare a complete passage plan to berth taking into account navigational conditions.
   - Using the data of the maneuvring of the vessel and weather conditions, to prepare a plan of approach to the berth, which contains the following information :
     - course and speed of approach;
     - the point at which the speed is reduced;
     - speed passage of a breakwater;
     - the position at which to reverse the engine;
     - the speed for approach to the berth.
   - To set the number of mooring lines and what mooring lines will be the first in any weather conditions, the vessels standing at the berth and port requirements.

Exercise No. 6. Mooring operations

1. Navigation area: Entrance to the port of New York.
2. Weather conditions: Wind 300º – 13 kts, current (variable).
   Tidal current (variable). Visibility – 10 miles.
3. Class of ship: General cargo, displacement – 5486.0 t, length – 104.8 m.
4. Initial data: Course – 000 °, speed – 0 kts.
5. The task purpose:
   To carry out entering into the port New York and mooring to the berth Starboard side of the loaded container vessel without tugs assistance.
6. Additional data:
   - Organization of watch with the passage to the port of New York under the conditions of intensive navigation in accordance with the requirements of the STCW Code, as amended, port regulations, COLREG and good seamanship.
   - To prepare a complete passage plan to berth taking into account navigational conditions.
   - Using the data of the maneuvring of the vessel and weather conditions, to prepare a plan of approach to the berth, which contains the following information:
     - course and speed of approach;
     - the point at which the speed is reduced;
     - speed passage of a breakwater;
     - the position at which to reverse the engine;
     - the speed for approach to the berth.
   - To set the number of mooring lines and what mooring lines will be the first in any weather condition, the vessels standing at the berth and port requirements.

Exercise No. 7. Unmooring operations

1. Navigation area: Port of New York.
2. Weather conditions: Wind 40º – 10 kts., current 000˚ – 1 kts.
   Tidal current (variable). Visibility – 10 miles.
3. Class of ship: Container vessel, displacement – 18600.0 t, length – 150 m.
4. Initial data: Stbd side alongside.
5. The task purpose:
   To carry out unmooring from the Terminal of the loaded container vessel without tugs in yje conditions of a current and wind.
6. Additional data:
   - To prepare a complete passage plan from harbour to harbour, taking account of the following:
     - information from sailing directions and other navigational publications;
     - draught, squat and depth of water;
     - tide and current, weather;
     - available navigational aids;
     - means of monitoring, progress and determining arrival at critical points;
     - expected traffic, traffic separation schemes;
     - requirements of vessel traffic services;
     - checklists for departure and for coastal waters.
   - Organization of watch for unmooring and departure from the port of New York under the conditions of intensive navigation in accordance with the requirements of the STCW Code, as amended, port regulations, COLREG and good seamanship.
   - Special features of unmooring and maneuvring under the squeezed conditions of container carrier with the thrusters device in to load condition without the aid of tugs with the joint action of flow and wind.
   - Responsibility for the safety of navigation is clearly defined at all times.

PART 3

SHIP'S INNER COMMUNICATION EQUIPMENT FOR EXECUTION AND MONITORING OF SAFE PASSAGE OF THE SHIP, CONTROL OF EQUIPMENT AND INFORMATION THAT IS RECEIVED FROM DIFFERENT EQUIPMENT DURING PASSAGE

ELĪNA DIMZA

INTRODUCTION

OBJECTIVE. To give an overview of the ship's inner communication equipment, needed for safe execution of the passage of the ship using correct and efficient passage planning, and to show what kind of equipment there is on board for safe passage execution, control and operation of a ship.

GOALS

1. To list and describe the inner communication equipment.
2. To list and describe safe navigation principles,
3. To describe safe passage planning,
4. To define how to execute and monitor safe passage of the ship.
5. To list and describe the bridge equipment and its particular use.
6. To describe interaction between all items of the bridge equipment.
7. To draw attention to the importance of full awareness of the bridge equipment.

PREVIOUS KNOWLEDGE AND SKILLS

Requirements for students.

- General knowledge of basic bridge navigational equipment.
- Participation in lecture courses “Navigation” and “Technical means of the ship”.

KNOWLEDGE, UNDERSTANDING AND PROFICIENCY
(as a part of the IMO Model course 7.03.)

1. Knowledge of the echo-sounder equipment.
2. Knowledge of the principles of magnetic and gyro-compasses.
3. Knowledge of the steering control systems, operational procedures and change-over from manual to automatic control and vice versa. Adjustment of controls for optimum performance.
4. Knowledge of the fundamentals of radar and automatic radar plotting aids (ARPA);
5. Principal types of ARPA, their display characteristics, performance standards and the dangers of over-reliance on ARPA.
6. Ability to operate, interpret, and analyse information obtained from ARPA.
7. General knowledge of the capability and limitations of ECDIS operations.
8. Knowledge of the log equipment and difference between speed through water and speed over ground with respect to collision avoidance.
9. Knowledge of principles of GPS and DGPS.
10. Knowledge of principles of Integrated Bridge Systems (IBS).
11. Knowledge of principles of Automatic Identification System (AIS).
12. Knowledge of using paper charts and nautical publications and their correction as per Notices to Mariners, etc.

3.1. SHIP’S INNER COMMUNICATION EQUIPMENT

3.1.1. Public announcement system

Communication systems provide a crucial part of effective everyday operation of the ship. The communication systems must be tested well in advance of the required time of use. The maintenance of public announcement (PA) system is a joint responsibility of all Navigation Officers, if not stated otherwise by company’s policy and Electrical Officer under the chief engineer.

PA system must be operational from all the stations or PA conning posts. The main post is on navigation bridge, secondary stations could be arranged on boat deck in the vicinity of muster station, and in the emergency in steering gear room. Bridge PA post is the one, which is used regularly so no doubt arises about its effective operation, but systems, which are not used on a regular basis are recommended to be checked at least once every month, for example during "Abandon ship" or "Lifeboat launching" drill. Loudspeakers of PA system are situated in the ship's common areas and outside the superstructure to provide the whole area is informed about the transmission of the intended message.

3.1.2. Walkie-talkies

Another equipment of ship's inner communication is walkie-talkies. These are very high frequency (VHF) portable radio stations that provide effective, fast and 24/7 radio communication on board ship among crew members. They can be used not only for communication between crew members to arrange, monitor and execute different tasks on board but also between a ship and shore staff, ship and other ship, or any other interested/involved side for safe execution of different jobs, or for getting/giving information.

The maintenance of portable VHF stations can be a responsibility of any of Junior Officers or Electric Engineer. Precautions must be taken in using walkie-talkies to prevent the entry of moisture / sea water inside, however there are also water resistant walkie-talkies that can be ordered to be delivered on board. If simple non-water resistant devices are used, then a simple polythene bag or "cling wrap" around the walkie-talkie is a good practice to prevent damage due to dust and rain.

Onboard the tankers, liquefied petroleum gas (LPG) and liquefied natural gas (LNG) carriers only intrinsically safe type of walkie-talkies should be used. Batteries should be charged only in gas safe areas.

3.1.3. Fire alarms

Fire alarms also can be classified as means of communication on board ship. If one wants to inform the whole crew of the ship about possible danger due to visible smoke or fire, he or she activates the fire alarm push button and raises alarm so that everyone is able to escape and proceed to muster station for further instructions from team leaders.

Fire alarms must never be reset without proper investigation regarding the cause of the triggering of the alarm. Modern equipment is reliable and usually does not give false alarms. There are mostly two main control panels on board ship to see the status of operation of the whole system, which includes the following (but is not limited to):

- status and type of fire detectors;
- list of fire detectors;
- list of zones (loops) and their status;
- status of inactive / disabled fire detectors (if some are under maintenance);
- particular zone (loop) status;
- triggered fire detector or loop number in case of alarm followed by sound signal.

The practice of switching-off a particular zone is strictly discouraged. Disabling of a fire zone must only be done for the minimum time necessary and only with the notification of the Duty Officer or Engineer. The Master and Chief

Engineer should be informed if the zone needs to be disabled for an extended period of time.

If any detector or loop is disconnected, a fire patrol must be maintained in the area that has been switched off.

For unmanned machinery space (UMS) ships, if any of the zones are not operational, the engine room must be manned. In such cases a notice must be posted in the vicinity of a fire alarm panel identifying which detectors or loops are isolated.

3.2. EXECUTION AND MONITORING OF SAFE PASSAGE OF THE SHIP

3.2.1. General information

As per STCW-95 Code, Chapter VIII, Section A – VIII/2 "the intended voyage shall be planned in advance taking into consideration all pertinent information, and any course laid down shall be checked before the voyage commences. Additionally to this, Chapter VIII sets down all standards regarding watchkeeping, which are described in this chapter. They must be followed at all times.

Watchkeeping Officers must be completely familiar with all the navigation and communication equipment, as well as with charts and publications. They should get acquainted with the content of operating manuals for equipment, they have to be familiar with setting up the controls and the procedures to be followed in the event of equipment failure.

Periodic checks of equipment must be carried out in accordance with the manufacturer's instructions. Any equipment, which has failures or defects, must be brought to the attention of the Master and other officers. These failures must be recorded in Deck Log Book, Radio Communication Log Book or / and in any other particular log book. That is the responsibility of the Officer of the Watch (OOW).

Regular preventive maintenance of all equipment should be carried out according to the instructions set out in the shipboard maintenance procedures manual and manufacturers' manuals.[1]

The sole objective of the procedures carried out on the bridge is to execute a safe voyage in regard to vessel, her complement, cargo and the environment.

The navigational procedures must be based on the following regulations and guidelines:

- Collision Regulations;
- Regulations Sec A-VIII/1 and 2 of STCW Convention 1995;
- flag state legislations;
- international regulations;
- local legislations, rules and regulations;
- the company's safety management system;
- Bridge Procedures Guide, ICS;
- Passage Planning Guide and Conduct of Sea Passages;
- IMO circulars.

The procedures are in no way meant to restrict or constrain the Master's or the Watchkeeping Officer's authority or contradict international, national or local regulations.

The basic principles are the following:

- common sense;
- situation awareness;

[1] Bridge Procedures Guide, 3rd Edition, Witherby Publishers, 1998. p.39.

- prudence;
- rational judgment;
- good practices of seamanship;
- prevailing circumstances and conditions;
- applicable international, national and local rules and regulations.

These principles are to remain the basis on which the Watchkeeping Officer and the Master make decisions. These procedures must be supplemented by the Master's standing orders, night orders and other instructions covering specific situations that may occur.[2]

3.2.2. Passage planning and voyage execution

The objective of planning is to make an appraisal of the hazards involved in advance and establish the most favourable route whilst maintaining appropriate margins of safety. The Master is responsible for ensuring that a comprehensive passage plan is prepared and executed. He may delegate the second officer and other navigating officers to prepare the passage plan for the voyage. Passage planning is a fundamental part of operating a vessel safely and hence prior to departure from a berth, as much of the plan must be completed as is possible. If the entire plan cannot be completed prior to sailing, the ship may depart providing that the first part of the passage plan has been completed. The remainder plan must be completed as soon as possible after sailing.

The four distinct stages in the development and execution of passage plan are briefly described as follows:

- appraisal;
- route planning;
- execution and monitoring;
- evaluation.

3.2.2.1. Appraisal

The appraisal stage of the passage planning shall be commenced as soon as the orders for the next voyage are received.

The appraisal shall pay due regards to the following:

- safety margins as applicable to the size and draught of the vessel;
- position and characteristics of navigational marks, lights, buoys, etc.;
- depth of water, expected current and tidal conditions;
- minimum under keel clearance (UKC) at each leg and squat effect;
- ship's maneuvring characteristics;
- meteorological conditions and ice limits / risks;
- traffic separation schemes;
- heavy traffic areas;
- possible fishing vessel density;
- speed restrictions imposed by local regulations;
- MARPOL special areas, particular sensitive sea areas (PSSA) and special emission control areas (SECA).

A passage plan can be divided into three different stages or legs, which cover the passage plan from berth to berth. It covers berth to pilot station (coastal and pilotage waters), pilot station to pilot station (coastal and open waters), pilot station to berth (coastal and pilotage waters).

Procurement of paper charts and publications. Requisition for charts and publications shall be made in advance, as soon as voyage orders are known, to ensure that they can be arranged in good time from outside sources, if they are not available locally. It shall be the Master's responsibility to ensure that

[2] Shipboard Procedures, AESM. 2007.

the largest scale charts are available for the passage. Navigation Officer shall be responsible for ensuring at the beginning of each passage that charts and publications for the passage are corrected and up-to-date.

To make sure that charts are corrected, he / she shall compare the correction numbers noted on the passage charts with the latest Admiralty Cumulative Lists of Notices to Mariners on board and all Weekly Notices to Mariners available on the vessel. Vessels having Digitrace / Chartco or other electronic systems must use the same to ensure that charts are corrected. If it is not possible to do so for any reason whatsoever, he / she shall bring it to the notice of the Master. Excuses that the previous Navigating Officer did not correct the charts will not be accepted.

In case a British Admiralty (BA) chart of an appropriate scale for any port approach is not available, the Master must check the availability of a large scale local chart for the area with the local agents. If there are any safety concerns about the lack of adequate charts for the port, the Master must immediately contact the office. All charts for the intended passage and for possible ports of refuge on the passage shall be on board. In an emergency, the Master has full authority to buy charts or publications required for the voyage through the local agents or chart suppliers.

If the charts are not available locally, the office must be contacted immediately.

In extreme emergencies such as diversion to a port for landing a casualty, copies of chart can be sent via email / fax, for reference purposes so that the dangerous areas are known. If an ECDIS is fitted onboard and the Admiralty Raster Chart Services (ARCS) or Electronic Navigational Charts (ENC) on CD are available onboard, please contact the office to obtain unlock codes via e-mail. In all such cases the Master must discuss the situation with the office operational department.

The Master remains responsible for obtaining the latest editions of charts and publications even if the ship subscribes to a folio management service. Any new charts should be added to the vessel's folio index and chart supplier, as necessary.

3.2.2.2. Route planning[3]

Any special requirements for the safe execution of the voyage should be conveyed to the office the soonest. In case the vessel is likely to encounter the hazards like "ice" during her voyage, the office must be advised by the departure port message or prior entering the hazardous waters. As long as it is practicable and safe for the vessel's size and draft, routes prescribed by the Ocean Passages of the World and the Sailing Directions shall be followed. If the routing decided by the Master is significantly different from the advice of the above publications, the Master shall advise the office about the intended routing and his reasons for choosing the particular routing. Local regulations must be checked up in Sailing Directions and Guide to Port Entry Publications, to make sure that the planned passage does not contravene local requirements. Certain sensitive areas such as the Great Lakes have speed restrictions, which must be strictly complied with at all times.

The routing shall, as far as possible, be the most economical considering the size and draught of the vessel and type of cargo she is carrying. However, at no time shall the safety of life and the safety of the vessel be compromised for economic reasons.

Masters shall bear in mind that time charterers / charterers or any other person does not have any authority to force the Master to take any particular route if the Master considers the route to be unsafe. If there is any doubt

[3] Shipboard Procedures, AESM. 2007.

regarding orders from the charterers about routing, the Master should seek advice from the office, explaining the situation. At times, the vessel may be advised to follow routes recommended by shore routing agencies (e.g. Ocean Routes) according to Charter Party clauses. Usually the routes advised by such agencies are the best in the weather conditions prevailing in that area, but if the Master has justifiable reasons to be concerned about the safety of the vessel, he may deviate from the advised route. The office and the charterers should be informed immediately in such cases, giving reasons for deviation from the route. Comments, if any, regarding the routing service must be sent to the company's Operational Department.

When planning ocean passages, the following should be consulted:

- small scale ocean planning and routeing charts providing information on ocean currents, winds, ice limits, etc.;
- gnomonic projection ocean charts for plotting great circle routes;
- the load line chart to ensure that the Load Line (LL) Rules are complied with;
- charts showing any relevant ships' routeing schemes.

The area near port approaches and in congested coastal waters shall be planned with utmost care, as the time available to take corrective action is likely to be limited.

The nautical book "Bridge Team Management" supplied in the ship's library is recommended for passage planning and monitoring techniques.

Parallel Indexing. Full use of the radar parallel indexing should be made, cross track monitoring by GPS and other techniques in monitoring the track of the vessel. The radar targets used should be safe and easy to identify, conspicuous, located outside the clutter and limited to a number sufficient for navigation. Parallel indexing techniques must be practiced frequently in clear weather.

Plotting Tracks. Though the tracks must be plotted taking currents into account, the safety of the vessel must not be endangered by going close to land or navigational hazards.

If the voyage distance is not increased by staying away from the coast, recommendation is to keep more than 50 nautical miles for tankers / gas carriers and 25 nautical miles for dry cargo ships from the nearest land.

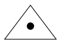
The presence of GPS equipment on board is an advantage, and getting close to land for position fixing is not required. Extra vigilance must be maintained if required to navigate within 25 miles off the coast.

When passing through restricted waters or areas of heavy traffic density, the track should be planned to facilitate transit in the starboard side of the fairway, for collision avoidance.

Position fixing. Position fixing frequency and method must be decided at the planning stages and incorporated in the passage plan. The frequency of position fixing should be such that the vessel does not get into danger during the interval between fixes. The most common frequency to be used is to fix the position twice the time ship can reach the closest danger proceeding at particular speed, e.g. if the speed of the ship is 10 knots and the closest danger is situated 5 nautical miles from the course line, the position must be fixed every 15 minutes.

The safe progress of the ship along the planned tracks should be closely monitored at all times. This will include regularly fixing the position of the ship, particularly after each course alteration. When changing charts, the position fix from the chart in use must be transferred to the new chart. At least two methods of position fixing should be charted, where possible.

As a standard, the following symbols are recommended for position fixes:

- GPS fix 
- radar / visual fix 
- DR Position 

Next thing, which has to be taken into account while planning the passage plan, is navigational (NAV) warnings and temporary and preliminary notices (T & P). Navigational warning must be taken throughout the passage. The NAV warnings, T & P notices and port information files must be checked up for passage planning.

The Navigating Officers must ensure that the NAVTEX and the Sat C EGC are set for the correct NAVAREAS for receiving the warnings. The Navigating Officers shall be responsible for taking NAV warnings at least two days prior entering an area. NAV warnings for the particular area must be taken each day, as long as the vessel is in that area. Long range navigational warnings must be taken regularly by the Navigating Officers.

A crucial thing is how well the contingency planning is done. So, while planning the passage in restricted waters and port approaches, contingency plans for the actions to be taken in the worst possible situations must be thought out and noted, e.g. actions to be taken in the following cases of:

- poor visibility;
- heavy weather;
- heavy radar clutter;
- missing buoys, or buoys not picked up on the radar;
- steering or engine breakdown;
- blackout;
- alternative routes if the normal route is unavailable.

If detailed planning for such situations has been done in advance, the response of the bridge team to any such situation will be better than a panic reaction taken when no thoughts have been given earlier for such problems.

MARPOL special areas and particularly sensitive sea areas (PSSA) are the ones that are most important while planning the passage. Due considerations shall be paid to protection of marine environment, especially to MARPOL special areas, PSSA and emission control areas (ECA) when planning the passage. During the planning stage of any voyage, if one or more of these areas are to be transited, the measures detailed for these areas must be strictly complied with.

A PSSA is subject to special discharge requirements and ship routing, because of its significance for recognized ecological, socio-economic, or scientific reasons, and because it may be vulnerable to damage by international shipping activities.

Whilst planning passage, due consideration must be given to transit through right whale reporting areas. It is illegal to approach closer than 500 yards (approx 460 metres) to any right whale. These requirements are given and can be found in the USA Code of Federal Regulations (50 CFR Part 222.32. Approaching North Atlantic right whales).

During the transit, all available information through Coast Guard voice broadcasts, National Oceanic and Atmospheric Administration (NOAA) weather radio, NAVTEX, local authorities and pilots for recent sighting reports should be obtained. If a right whale is sighted from the vessel or reported along the intended track, mariners should exercise caution and maintain a safe speed within a few miles of the sighting location. The following facts should be remembered:

- reduction of speed minimizes the risk of vessel strike;
- do not assume that right whales will move out of your way;
- right whales are slow swimmers, seldom travelling faster than 5 knots;
- their direction of travel may change suddenly;
- they often travel in small groups that may be dispersed over an area of several miles.

Any whale accidentally struck or any dead whale carcass should be reported immediately to the coast guard. The following details must be furnished:

- location and time of accident;

- speed of the vessel;
- size of the vessel;
- water depth;
- description of the impact;
- fate of the animal;
- species and size, if known.

Returning to the plan itself, it is a tool to monitor the progress of the passage with regards to the planned parameters. Regarding planning the passage on the charts, prior to proceeding to sea, the Master shall ensure that the intended voyage has been planned using appropriate charts and publications for the area concerned. Passage planning should be carried out on the chart to the extent that important information is readily available on the chart to assist the bridge team. Overcrowding of information in the working areas of the chart can be avoided by recording the information away from the track and drawing attention to it by a line or reference letter.

The following should be marked on the chart, where it enhances safe navigation:

- parallel indexing (not from floating objects unless they have been first checked for position);
- minimum under keel clearance;
- chart changes;
- methods and frequency of position fixing;
- prominent navigation and radar conspicuous marks;
- no-go areas;
- landfall targets and lights;
- clearing lines and bearings;
- transits, heading marks and leading lines;
- significant tides or current;
- safe speed and necessary speed alterations including speed restrictions as imposed by local regulations;
- planned changes in machinery status / speed;
- positions where the echo sounder should be activated;
- crossing and high density traffic areas including high density of fishing traffic;
- safe distance off;
- anchor clearance / removal of anchor lashings;
- contingency plans;
- abort positions or positions of "no-return", i.e. after which the ship is committed to a channel;
- VTS and reporting points, etc.

Charted passage planning information should not obscure printed details, nor should the information on charts be obliterated by the use of highlight or felt-tip pen, red pencil, etc.

No-go areas should be highlighted with pencil (no highlighter or pens), but should be reserved for those areas where the attention of the navigator is to be drawn to a danger such as shallow water or a wreck close to the course line. Extensive use of no-go areas should be discouraged. No-go areas vary with change of draft and tide and will therefore also vary with the time of passage. They should not therefore be permanently marked.

All previous courses but the one in use should be erased. Course lines must not be marked in ink.

The manoeuvring data regarding turning and stopping distances is given for calm weather conditions. Manoeuvring characteristics chart (wheelhouse poster) must be displayed on the bridge. It must be borne in mind that in stronger wind and current conditions, the turning and stopping distances may be significantly longer, and could well be twice the distances given in the manoeuvring data.

In all areas of optional pilotage if the master wishes to have the services of a pilot, as far as possible he should inform the charterers in sufficient time to make necessary arrangements. If the charterers request the Master to avoid taking a pilot in an area of optional pilotage, and offers an “incentive” or “bonus” in return, the Master must inform the office management immediately and get approval. The safety of life and that of the vessel must not be compromised under any circumstances.

Capesize / VLCC / VLGC vessels, in general, must not transit through the Malacca / Singapore Strait for both laden and ballast voyage, to and from Far East ports, unless required to call at Singapore for any reason. The Lombok Strait may be used instead.

3.2.2.3. Route planning using electronic charts[4]

To use ECDIS as a stand-alone system without paper charts, both fully independent, IMO type-approved vector chart systems are required. If only one unit is fitted, the vessel can only use the ECDIS as a secondary navigational aid, and a fully corrected paper chart folio remains as the primary system.

Masters and all Navigating Officers on ships fitted with IMO approved and operational ECDIS as primary means of navigation must have received formal training on the use of the ECDIS equipment ashore.

On vessels fitted with operational ECDIS / ECS, the company shall endeavour to provide suitable familiarization training to all Navigating Officers onboard by either course ashore or by company provided computer based training.

Official ENCs should be used for ports and port approaches. ARCS charts are official charts issued by UK DOT, but these being raster charts the full functions of ECDIS cannot be used. Transas / C-map or other privately published charts are official and can be used as aids to navigation with or without paper charts for navigation.

In addition to the paper publications necessary for a safe passage, the following issues should be taken into consideration for electronic passage planning:

- the vessel’s controlling operational parameters (maximum draft, air draft, turning data, minimum UKC required, “look ahead” distance, etc.) should be entered;
- the GPS position system input should be set to WGS 84 datum;
- the alarm functions of the ECDIS should be fully operational; they will alert the operator to any dangers exposed in good time during the voyage;
- the electronic chart coverage for the voyage must be adequate;
- the electronic charts must be fully corrected for the intended voyage.

Marking / highlighting of electronic charts can be carried out in a similar way to paper charts to identify radar conspicuous targets, no-go areas, parallel index lines (essential for the monitoring stage), transit marks, clearing bearings, etc. It is prudent for a simulated passage to enter all the above mentioned prior to the vessel’s departure to ensure that the route does not arise any alarm preset danger areas that may have been overlooked. Estimated positions should be marked on both paper and electronic chart for each watch in advance.

When passage planning using ECDIS, the Navigating Officer should be aware that a safety contour can be established around the ship. The crossing of a safety contour, by attempting to enter water, which is too shallow, or attempting to cross the boundary of a prohibited or specially defined area such as a traffic separation zone, will be automatically indicated by ECDIS while the route is both being planned and executed.

4 Shipboard Procedures, AESM. 2007.

Where a passage is planned using paper charts, care should be taken when transferring the details of the plan to an electronic chart display system. In particular, the Navigating Officer should ensure the following:

- positions are transferred to, and are verified on electronic charts to equivalent scale to that of the paper chart on which the position was originally plotted;
- any known difference in chart datum between that used by the paper chart and that used by the electronic chart display system is applied to the transferred positions;
- the complete passage plan as displayed on the electronic chart display system is checked for accuracy and completeness before it is used.

Care must also be taken when transferring route plans to electronic navigation aids such as GPS, since the ship's position that is computed by the NAVAID is likely to be in WGS84 datum. Route plans sent to the GPS for monitoring cross track errors must therefore be of the same datum.

Similarly in the case of radars, routes and maps displayed on the radar will be referenced to the position of the ship. Care must therefore be taken to ensure that maps and plans transferred to, or prepared on the radar, are created in the same datum as the NAVAID (typically a GPS), which is connected to and transmitting positions to the radar.[5]

3.2.2.4. Monitoring and execution

Navigating Officers must not become over-reliant on ECDIS. Frequent checks should be made of the ECDIS position fixing system (normally GPS) by the use of other means. Such checks should include the following:

- parallel indexing and use of clearing bearings;
- use of radar to check the accuracy of the charted position by comparing the location of the radar target against the charted symbol;
- visual cross bearings;
- comparison of the signal to noise ratio of the GPS system in use.

Full functionality of ECDIS cannot be achieved when operating in the raster chart display (RCDS) mode, and thus the system should always be operated in ECDIS mode. Data input from the gyrocompass, speed log, echo sounder and other electronic equipment should be periodically monitored to ensure accuracy.

Prior to entering congested or restricted waters, especially after long open sea passages, the Master must discuss the passage plan in detail with all of the Navigating Officers and Chief Engineer. He must caution the officers regarding the dangers and problems that could be encountered during the passage. Caution must be exercised against lack of alertness due to familiarity of routes. This meeting is extremely important for the functioning of a good bridge team. The company strictly recommends a de-briefing to be conducted upon completion of passage, and any important information forwarded to the office.

An arrival / departure checklist suitable to each ship, designed on similar lines to the checklist shown in sample checklists, must be filled out for each port or anchorage arrival and departure. It is once again emphasized that the purpose of the checklist is only to assist in running the vessel in a safe manner. The checklist must not be filled in only for the sake of records.

In heavy traffic areas, two steering gear units must be run simultaneously wherever such operation is possible.

Oil Companies International Marine Forum (OCIMF) Guidelines must be followed and STS Transfer Guides (Petroleum or LPG) must be referred to when carrying out such operations on tankers and gas carriers. Every company's specific guidelines laid in Tanker Operations Manual / Gas Carrier Manual / Chemical Tanker Manual must be complied with during operations.

[5] Bridge Procedures Guide, 3rd Edition, Witherby Publishers. 1998. p.19.

The Master must ensure that the officers take celestial observations frequently enough to remain familiar and have the confidence to take sights when required.

It is recommended that all vessels shall participate in the Automated Mutual-Assistance Vessel Rescue System (AMVER) that is a position reporting system. Reporting can be done via e-mail or Sat-C. All necessary reporting formats can be found in Admiralty Digital Publications (ADP) available on board. Local systems should also be followed as appropriate. AMVER and other local reporting systems have the following report types with little variations.

- Sailing Plan. It contains complete routing information and should be sent before, upon, or within a few hours after departure.
- Position Report. It should be sent within 24 hours of departure and subsequently at least every 48 hours until arrival. The destination should also be included in Position Reports. At the discretion of the Master, reports may be sent more frequently, e.g. during heavy weather or other adverse conditions.
- Deviation Report. It should be sent as soon as any voyage information changes, which could affect AMVER's ability to accurately predict the vessel's position. Changes in course or speed due to weather, ice, change in destination, or any other deviations from the original sailing plan should be reported as soon as possible.
- Arrival Report. It should be sent upon arrival at the sea buoy or port of destination.

All vessels shall, as far as possible, send weather observations to coast radio stations.

3.3. CONTROL OF EQUIPMENT AND INFORMATION RECEIVED FROM DIFFERENT EQUIPMENT DURING THE PASSAGE

3.3.1. Radar and ARPA

The radar is free for use by all officers.

- At least one radar must be kept running at all times whilst underway and at anchor.
- The second radar, if fitted, must be used whenever required and especially during restricted visibility, heavy traffic areas, congested / restricted waters, etc.
- Targets must be plotted and all information regarding course, speed, CPA and TCPA must be obtained and analysed.
- Manufacturer's manuals must be read and understood thoroughly by all users.

The Master must encourage the practice of radar plotting in clear weather for comparison with visual observations, so that the officers gain confidence in their ability to use and properly interpret the information obtained by the ARPA. The practice and confidence obtained in clear weather will help in crucial periods when a quick decision is necessary to avoid danger.

A diagram showing blind and shadow sectors should be placed near the radars. The performance of the radar must be checked and recorded daily with the help of the performance monitor if fitted or by observing the sea clutter. It must be borne in mind that echoes may be obscured by sea or rain clutter and that small vessels, fishing vessels, small icebergs and floating objects may escape detection. Judicious use of clutter control will assist.

The accuracy of the variable range marker (VRM), electronic bearing line (EBL) and the heading marker must be checked each time the radar is switched on and during every watch.

Range scales must be changed frequently including long range scanning, to ensure sufficient time for an early appraisal of the situation, especially in restricted waters, when short range scales are in use. When a target of interest comes closer, reduce the range scale so that it appears in 50–90 % of the display radius.

The Master is responsible to inform the office immediately if the radars are not functioning properly. Repairs are usually arranged only by manufacturers' agents. In general, radars should be checked annually. Radar Maintenance Logs must be maintained in the Planned Maintenance System or on hard copy. The Master must verify that a record of radar operation is being maintained, including records of performance monitoring.

Radar and automatic radar plotting aid (ARPA) speed input must be in *through the water mode* (forward speed) as per IMO Res. A.823 (19) (Performance Standards for Automatic Radar Plotting Aids (ARPAs)). Most commonly available and used own ship's speed inputs are LOG(BT) – log speed over ground (also SOG), LOG(WT) – log speed through water (also STW), GPS – speed input by GPS navigator. It must be clearly understood that wrong input of speed can cause very serious errors in the vectors calculated by the ARPA, thus giving incorrect speed and heading of the other vessel. The speed input should therefore be checked frequently. Speed input from log should only be used and GPS speed should not be used. Wrong input of headings can also cause serious errors.

Adjusting the sensitivity of the radar or most commonly used as a gain control function on the panel reduces or increases the background noise and strengthens the echoes of the targets on the screen. Using too little sensitivity leads to weak echo missing. Excessive sensitivity causes too much background noise and strong targets may be missed because of the poor contrast between the desired echoes and the background noise on the display. To adjust receiver sensitivity, adjust the gain control so background noise is just visible on the screen.

Mutual radar interference also may occur when operating the radar. It may occur when another shipborne radar is operating in the vicinity in the same frequency band. It appears as curved irregular patterns on display. To reduce it, interference rejector can be used, most commonly found as *INT REJECT* function. The highest number of this function provides the highest degree of suppression.

The echo stretch feature enlarges targets in the range and bearing directions to make them easier to see, and it is available on any range. There are three types of echo stretch. The higher the amount (1, 2, 3) the greater the amount of stretching. But it must be noted that echo stretch magnifies not only small target pips but also returns (clutter) from sea surface, rain and radar interference.

Parallel index lines are useful for keeping a constant distance between own ship and a coastline or a partner ship when navigating. Two or more index lines are available and may be displayed.

Frequent practice must be done by the OOWs in clear weather and under conditions of low traffic density, including trial manoeuvre function on the ARPA, to gain confidence on the equipment. The manufacturer's manual must be thoroughly understood in order to reap full benefits of all the features of ARPA. It must be understood that targets may enter the "guard zone" without setting off the alarm. Auto acquisition of targets is a useful feature but it cannot be relied upon fully.

It must be borne in mind that the closest point of approach (CPA), course, speed, etc., as calculated by the ARPA, have inherent inaccuracies according to the limitations of the equipment and, therefore, a CPA of less than 1 nm must be considered with extreme caution. CPA / TCPA alarms must be set on ARPA appropriate to the circumstances of the case. It must be ensured that these alarms are not muted. Furthermore, the urge to cancel the CPA / TCPA alarm without checking the cause due to repeated activation must be guarded against. It is important to remember when using ARPA for collision avoidance, the ship's speed through the water should be used rather than speed over ground. The use of ground stabilized mode must be avoided for anti-collision use operation.

When a target being tracked nears another target being tracked, the targets may be "swapped". When two targets acquired come close to each other, one of them (or two) may become "lost target". Information gained from ARPA must be fully understood. The following abbreviations are given for comprehension:

- BRG – bearing from own ship to target in R (relative) or T (true) motion;
- RNG – range from own ship to target;
- COG – course of target over ground, true or relative (CSE or STW are shown);
- SOG – speed over ground;
- CPA – closest point of approach of target to own ship;
- TCPA – time to CPA;
- BCR – bow cross range of target;
- BCT – bow crossing time of target.

Radars can have set and drift corrections available for increasing accuracy of vectors and target data. SET is the direction in which a water current flows. It can be manually entered in 0.1 degree steps. Drift is in another word rate – the speed of tide. It can also be entered manually in 0.1 knot steps. If stationery targets have vectors, set and drift values should be adjusted until they lose vectors. Set and drift is available when using water-tracking log. The speed source is shown as WTC in this case. Set and drift corrections should be checked periodically for correctness.

Setting correct CPA / TCPA alarm ranges is essential when avoiding collisions or close quarter situations. ARP releases an audible alarm and displays the warning label "collision" on the screen. In addition, the ARP symbol changes to a triangle and flashes red together with its vector. CPA/TCPA alarm ranges must be set up properly taking into consideration the size, tonnage, speed, turning performance and other characteristics. The reference point for CPA/TCPA calculations may be chosen from antenna position or conning position.

If OOW wishes to create a guard zone (GZ), it can be done having 360 degrees coverage by setting up both points of the beginning and end of GZ in almost the same direction. It must be born in mind that GZ may not detect small objects or targets. Appropriate radar set-up must be done according to weather and traffic conditions. GZ can be also created in just one direction of interest with smaller range of degrees, e.g. to detect vessels, which are crossing from starboard side.

Six main situations that cause the ARP to trigger visual and audible alarms are as follows:

- collision alarm;
- GZ alarm;
- lost target alarm;
- target full alarm for manual acquisition;
- target full alarm for automatic acquisition;
- system failure.

There is also a trial manoeuvre function on ARPA. The trial manoeuvre feature simulates the effect on all tracked targets against own ship manoeuvre without interrupting the updating of target information. It is available for use with ARPA function.

Dynamic trial manoeuvre displays predicted positions of the tracked targets and own ship. OOW has to enter own ship's intended speed and course with a certain "delay time", assuming that all targets maintain their present speed and course. The future movements of targets and own ship are simulated in one-second increments indicating their predicted positions in one-minute intervals. Static trial manoeuvre displays only the final situation of the simulation.

The factors affecting ARP functions are as follows:

- sea returns (anti-sea clutter);
- rain and snow (A/C Rain);
- low clouds (usually no effect);
- low gain (use proper gain);
- second trace echoes;
- blind and shadow sectors;
- indirect echoes;
- radar interference (*INT REJECT* can clean the display).

Regular maintenance is essential to good performance. A good performance program should be established and should at least include the items shown in Table 3.1.

Table 3.1

Radar Equipment Maintenance Schedule (Furuno Radar Technical Manual)

Interval	Check point	Check and measures	Remarks
When needed	The LCD will in time accumulate a layer of dust, which tends to dim the picture	Wipe the LCD carefully to prevent scratching, using tissue paper and an LCD cleaner. To remove stubborn dirt, use an LCD cleaner, wiping slowly with tissue paper so as to dissolve the dirt. Change paper frequently so the dirt will not scratch the LCD.	Do not use chemical-based cleaners to clean the LCD. They can remove paint and markings.
	Processor unit cleanliness	Dust and dirt may be removed with a soft cloth.	Do not use chemical-based cleaners to clean the processor unit. They can remove paint and markings.
3 to 6 months	Exposed nuts and bolts on antenna unit	Check for corroded or loosened nuts or bolts. If necessary, clean and repaint them thickly. Replace them if heavily corroded.	Sealing compound may be used instead of paint. Apply a small amount of grease between nuts and bolts for easy removal in future.
	Antenna radiator	Check for dirt and cracks on radiator surface. Thick dirt should be wiped off with soft clot dampened with fresh water. If a crack is found, apply a slight amount of sealing compound or adhesive as a temporary remedy, then call for repair.	Do not use chemical-based cleaners for cleaning. They can remove paint and markings. To remove ice from the antenna unit, use a wooden hammer or plastic head hammer. Crack on the unit may cause water ingress, causing serious damages to internal circuits.
	Terminal strips and plugs in antenna unit (technicians only)	Open antenna cover to check terminal strip and plug connections inside. Also check the rubber gasket of antenna covers for deterioration.	When closing antenna covers in position, be careful not to catch loose wires between covers and unit.
6 months to 1 year	Terminal strips, sockets, earth terminal on processor unit (technicians only)	Check for loose connections. Check contacts and plugs for proper seating, etc.	

3.3.2. Compasses

The gyro and magnetic compasses are critical equipment and special attention must be paid to them. The responsible officer, usually the 2nd Officer, must test the gyro alarm at least once a day. All gyro repeaters must be compared with the master compass, once every watch. Latitude / speed correction controls for the gyro must be checked and adjusted, if necessary, every watch by the relieving officer. The gyrocompass must be serviced annually, or as recommended by the manufacturer's instructions, by an authorized service engineer. Great caution must be exercised and errors must be taken frequently whenever the gyro is stopped and restarted, e.g. after drydocks or annual servicing.

All liquid magnetic compasses should be checked monthly for air bubbles. They should be kept covered at all times when not in use. Maintenance of the gyrocompass will be the responsibility of the 2nd Officer. Electrical Officer, Radio Officer and the Chief Engineer shall assist if required.

The magnetic compass is generally fitted above the bridge on the centreline with a periscope so that the compass is readable from the helmsman's position. When the magnetic compass is needed to provide heading outputs to other bridge systems, a transmitting magnetic compass (TMC) is fitted. TMC outputs should be corrected to compass error and the TMC should be tested once a week, in clear visibility.[6]

TMC provides digital signal to the steering stand. The signal is utilized for the following purposes:

- providing digital reading of magnetic compass heading;
- alarm indication, in case difference between gyro and magnetic exceeds preset limit;
- off-course alarm;
- driving all repeaters, in case of gyro failure;
- auto steering, using magnetic compass.

For proper operation of this system, it must be ensured that the following is done:

- magnetic variation is correctly fed;
- a separate deviation card is made for the TMC repeater and the same is used when steering, using TMC repeater.

This is due to the difference in distance between the magnetic correctors from the standard compass card and the transmitting element of TMC, resulting in some error (up to 2.5 degrees) in TMC readings.

The Master must check and initial the compass error log every month. The latest compass deviation curve should be posted in a conspicuous location on the bridge. All previous compass curves from the last adjustment must be kept safely onboard. After adjustment, the deviation curve should have a near zero value.

Compass error must be checked and recorded as far as possible once every watch and wherever possible after a large alteration of course that has been carried out. The observed deviation should be compared with the residual deviation curve. In case of constant excessive deviation (above 5 degrees), the compass should be swung, and new curve drawn. The vessel should be swung annually by the ship's staff, and a new residual deviation curve drawn. Certain cargoes being carried may adversely affect compass efficiency and warrant an early check of the curve.

Under the following circumstances, the compass should be adjusted by certified compass adjustor:

- after every dry-docking or major lay-up (when structural changes have been carried out);

[6] Bridge Procedures Guide, 3rd Edition, Witherby Publishers. 1998. p. 44.

- in case the observed deviation values remain above 5 degrees.

Regarding gyrocompass, it is recommended to be run continuously. If it stops for any reason or has some failures, it should be restarted and subsequently checked before being used for navigation again. It must be ensured that the gyrocompass has "settled" into meridian and is using the right calculation of true meridian. Speed and latitude corrections also have to be applied to gyrocompass. Where the gyrocompass has no direct speed log or position input from GPS, manual corrections have to be made as required. Gyrocompass has several repeaters. They can be situated on bridge wings, on autopilot console and also in the emergency steering gear room for smooth heading readings when navigating the vessel in an emergency, i.e. steering gear failure. Gyrocompass repeaters on the bridge should be checked against the main gyrocompass at least once every watch, and after excessive manoeuvring.

Rate of turn indicators are also found on bridge. They are used by automatic track-keeping systems to perform controlled turns. When ships are manoeuvring, rate of turn identification provides the ship handler with information on how quickly she is turning. This is important to observe when handling particularly large vessels where the distance between the bow and the pivot point is considerable.

3.3.3. Steering gear and autopilot

Steering control of the ship can be provided by manual steering, automatic pilot or autopilot and / or other track control system. It is highly recommended to keep navigational watch so that there is no development of dangerous situations due to improper use of autopilot. The Helmsman should be available for assistance continuously so that the OOW can do continuous look-out.

The role of the autopilot is to steer the ship automatically. It can be operated independently or by integrated system. The course control and track control operation is discussed further.

Main steering gear requirements are the following.

- Manual steering must be tested at least once every watch by OOW.
- Non-follow-up (NFU) steering must be tried out each day by the responsible officer.
- Clear instructions for change over from manual steering to autopilot must be posted near the controls.
- The changeover from manual steering to autopilot and vice versa must be done under the supervision of the OOW.
- Clear instructions and a block diagram explaining the changeover procedures for emergency steering must be posted near the steering position and at the emergency steering station in the steering room. These instructions must be in a simple, easy to understand form.
- Simplified instructions must be posted in addition to the detailed instructions placed by the shipyard on some ships. Usually these instructions are made by the Chief Engineer.

The off-course alarm is for warning the OOW when the vessel deviates from its course. The alarm should be in use at all times when the autopilot is in operation but that does not relieve the OOW from frequent checks of the course steered. Off-course alarm must be adjusted to suit the prevailing weather conditions. In general, for fair weather conditions the off-course alarms can be set to 5 degrees.

As mentioned before, there are different operational modes of autopilot system. In case of follow-up (FU) control, the rudder is caused to automatically take this position. In case of NFU control, the rudder moves in the pre-selected direction as long as the tiller is being actuated. Checking of the instantaneous rudder angle is to be made in this case by observing the rudder position indicator.

Course control operation is automatically activated when switching over from manual to automatic control. In addition, an alarm threshold for the off-course and course monitor alarm and a limit value for rudder limitation can be entered.

The actual course indicator can indicate the magnetic course or gyro-course depending on which one is chosen. When using magnetic course, it displays "MAG", and when using gyro-course, it is "GYRO" exhibited on the display.

Rate of turn (ROT) tiller operation is the next possible way to steer the vessel. This is usually meant to be used when steering the ship for special manoeuvres and when sailing in rivers, channels and in estuaries. ROT tiller operation is effective to be used by the Master or OOW when it is essential to keep good look-out by visual and radar means. Tiller is usually positioned near the main radar or conning position, away from the autopilot central console.

In case of track control, the ship is taken along the connecting line between two way-points. Lateral deviations due to wind or current are compensated by automatic variation of the course set on the course controller. It allows the ship to maintain her planned track.

The operating mode "Track control" can be activated only when starting out from the course control or ROT tiller operation with the connected track planning system, the user is being supported and guided by indicators on the operator unit. One of the control properties of the track controller is wheel-over-point (WOP). It lets the vessel to approach the new track with the preselected rate of turn. Track deviation increases significantly in case of a low preset rate of turn. Turns are commenced at a WOP only after the OOW has acknowledged the WOP alarm and is satisfied that it is safe to execute the turn. If any malfunction occurs, the system automatically turns to course control operation and alarm activates. There are the following checks to be made before departure:

- switch on steering gear;
- steering mode selector to "Auto";
- compare actual course with compass course;
- after the set course by 5 degrees to port, the rudder must follow up;
- after the set course by 5 degrees to starboard, correspondingly.

Automatic steering modes (course control, track control) must be used only when the expectable steering accuracy complies with the traffic and navigational situation. Special care must be taken in confined waters. When the ship starts turning, the rate of turn may be increased even up to by 50 %.

3.3.4. Speed and distance measuring log

Depending on a speed log type, it will provide either speed through the water or speed over the ground.

For collision avoidance, it is obligatory to use speed through the water as mentioned in this chapter before, and speed over the ground is used for navigational purposes. The speed that the ship has achieved over the period of time is called "speed made good" and also can be measured on ships by taking it from the chart position fixes or calculated and transmitted by electronic position-fixing systems.

Doppler log is the equipment for measuring the speed and the run of the ship, utilizing the Doppler shift of ultrasonic signals, which are radiated from transducer into the sea water downward obliquely to the bow and stern sides, then scattered and reflected into the sea water. This is dual-axis Doppler type (also single-axis is common when measuring speed only in the fore and aft direction). Coupled with rate of turn measurement, these logs are also able to calculate the speed and direction of movement of the bow and stern.

Usually exactly this type of log is an equipment used for precise measurement. The transducer is mounted on the hull bottom. Equipment measures a relative speed to seawater from the hull bottom within around 3 metres (depending on manufacturer's equipment characteristics). Therefore, the ship's speed corresponding to the output of the main engine can be obtained without containing the speed of currents.

The ship's speed error margin caused by the change in the water line does not occur because the transmission and the reception of the pulse is done, and it excludes the signal in the vicinity of the bottom of the ship. Moreover, because the dual beam method of sending the ultrasonic wave signal in two directions (fore and aft) is adopted, the ship's speed error margin is greatly reduced because of change in the trim. Usually equipment offers measured information to other equipment on the bridge, such as radars, ECDIS, etc. If a ship is fitted with high accuracy impulse Doppler system of high frequency ultrasonic signals, the signals reflected from approximately 2 to 3 meters underwater below the hull bottom are tracked to detect their Doppler frequency shifts, ensuring highly accurate measurement of the own ship's speed through the water without being effected by following waves.[7]

3.3.5. Echo sounder

The echo sounder recorder should be switched on prior to entry into shallow water and in port entrance, and prior to departure. It should remain in operation while in shallow waters (depths less than 50 m). The date and time of switching on should be marked on the recorder chart. In addition, the date and time of passing significant land- or seamarks should be marked on the recorder.

The Master must verify that the echo sounder records are maintained in the deck log book. This is especially important in cases of vessels fitted with digital echo sounder with no printer feed for the recording.

Whenever the vessel is within a depth less than two times the draught, soundings must be taken frequently and logged down. The Master must encourage the use of the echo sounder and frequent practice of identifying the vessel's position with the aid of the echo sounder. Depth alarms, if fitted, should be used in accordance with the equipment manufacturer's instructions. All navigation officers must be familiar with the echo sounder operation to exclude mistakes that can be made due to lack of knowledge of setting up the device, e.g. depth alarms must be set up so that it will warn the bridge team of unexpected shallow water on a planned route, for the navigators to know when the ship deviated from her route, or the underwater dangers were not reported.

The navigational echo sounder should be operative to depths of at least 200 m. Nowadays echo sounders operate to depths more than this. It must be checked if the units on the echo sounder match the units used on the chart to avoid misunderstanding and room for errors. When comparing these soundings, the corrections must be made for the tidal levels, drought of the ship, squat effect, etc.

The maintenance of the echo sounder is the responsibility of the Navigating Officer (usually the 2nd Officer). The Electrical Officer, guided by the Chief Engineer, should assist if required.

7 Instructional Manual of JRC JLN-205 Doppler log, Japan Radio & Co Ltd, 2005.

3.3.6. GPS and DGPS

Global positioning system (GPS) and differential GPS (DGPS) provide global positioning capability. GPS accuracy is of 100 meters but DGPS – of 10 meters.

The signal from the satellites is sent to the GPS device so that a user can determine the position. It must be borne in mind that wrong input of initial position (DR), initial date and time, and antenna height can cause substantive errors in the GPS position.

It must be borne in mind that GPS positions are also not free from errors, and must not be fully relied upon, especially in very narrow / congested waters, without cross checking with alternate position fixing system. In restricted waters, radars must also be used to confirm position of the vessel, rather than fully relying on the GPS.

Good practise is to have two working GPSs onboard, and it is extremely important to check that the "datum" is in use by the equipment and the chart is exactly the same. Use of a different datum can cause significant errors in the position obtained. Generally, WGS-84 (World Geodetic system of 1984) datum should be selected as the basic reception base in the receiver. It is then possible to enter datum shift corrections from the chart into the receiver thus enabling the correct position to be displayed on the receiver, which can be plotted directly onto the charts.

DGPS positions are also affected by certain errors. Hence it is important that in very restricted waters, alternate means of position fixing (e.g. radar) are also used to verify the ship's position.

If a GPS speed input through the NMEA is available into the radar / ARPA, it must be borne in mind that speed over the ground would be fed to the ARPA and the output data provided by ARPA could be dangerous when taking collision avoidance action in areas with significant tidal streams and currents. NMEA is a standard of interface data between various pieces of marine electronic equipment developed by the National Marine Electronics Association (NMEA).

Usually it is the second officer to be responsible for the maintenance of the equipment as per the manufacturer's instructions.

A record of GPS positions shall be maintained in the deck log book. The Master shall verify that the record is being maintained properly. It is good practice to record the position at every change of watch and at every alteration of course.

3.3.7. Integrated bridge systems (IBS)[8]

An IBS is a combination of systems, which are connected to each other to allow centralised monitoring and control of sensor information and operations, such as execution of the passage, communications, safety and control of machinery and equipment, cargo operations and security.

There is no single standard regarding IBS certification, but classification societies offer some examples for IBS arrangements, designed to support periodic one man operations, e.g. "NAV1" is offered by Lloyd's Register, "OMBO" – by American Bureau of Shipping, etc.

The Wartsila Encyclopaedia defines IBS as "a series of interconnected and closely grouped screens and modules allowing centralised access to navigational, propulsion, control and monitoring information. The aim of IBS is to increase safe and efficient ship management by the qualified personnel."

[8] https://www.marineinsight.com/marine-navigation/what-is-integrated-bridge-system-ibs-on-ships/ 19.11.2017.

To allow centralised access to all the above mentioned, IBS usually consists of the following equipment but is not limited to:

- autopilot;
- radar / ARPA;
- gyro compass;
- GPS/DGPS;
- ECDIS (master + backup);
- conning display to allow centralised access to all the necessary information given to OOW;
- power distribution system;
- steering gear;
- GMDSS.

The design of IBS should also allow two bridge members to work with information without distracting each other. There should be proper access into and around the bridge, and adequate visibility from all the conning stations. Good working environment is essential when talking about IBS and its use in everyday safe navigation / operation of the ship.

ECDIS, GPS / DGPS, log, autopilot, gyrocompass and radar / ARPA all together can be named a navigational management system to provide the mechanism for planning, execution and monitoring of the passage plan. It provides the link between all equipment.

The conning display should be available at the conning position to show information summaries of the important navigational sensors used on passage and while docking.

According to SOLAS Chapter V, Reg. 19, Para 6 "Integrated bridge systems shall be so arranged that failure of one sub-system is brought to the immediate attention of the officer in charge of the navigational watch by audible and visual alarms, and does not cause failure to any other sub-system. In case of failure in one part of an integrated navigational system, it shall be possible to operate each other individual item of equipment or part of the system separately".

The IBS is equipped with alarm system to warn the OOW if any potentially dangerous situations could arise. An alarm system links all the above mentioned systems and gives out audio and visual signal in case of an emergency condition. In most ships, an additional alarm connected to the IBS is also fitted in the cabins of the navigating officers. This alarm provides a signal in the cabins within 30 seconds in case the officer in charge fails to acknowledge the alarm.

The alarm system should also include a watch safety or fitness alarm to monitor the alertness of the OOW. The latter is also called the bridge navigation watch alarm system (BNWAS). A number of alarm acknowledgement points, each with a pre-warning alarm to give the OOW notices that the alarm is about to be activated, should be available around the bridge. As with the failure of the OOW to acknowledge a navigation alarm, if the fitness time interval expires, an alarm should also be sounded in common areas such as officers' deck or / and Master's cabin. An interval timer for setting alarm intervals of up to 12 minutes is a maximum.

Bridge operation can be safely automated only when certain procedures and disciplines are followed, e.g. passage plan is thoroughly prepared on charts and checked for any errors, all the waypoints must be carefully checked and transferred to the navigation system, operation of autopilot must be checked and tested to allow it follow the track control.

Clear instructions and procedures must be written in shipboard procedures manual.

Always pay attention to visual navigation and watchkeeping techniques. Over reliance on equipment can be dangerous and may lead to loss of life and cargo, marine pollution and bad reputation.

3.3.8. Paper charts, publications and ECDIS

All charts and publications on board should be kept corrected to the latest "Notice to Mariners" available on board. Charts must be corrected using the Notices to Mariners of the hydrographic office that had produced them. The charts and publications for the voyage must be corrected before correcting those for the other areas.

Additionally to up-to-date charts, vessel should carry adequate official sailing directions, list of lights, Notices to Mariners, tide tables and all other nautical publications necessary for intended voyage.

Usually the 2nd Officer is in charge of correcting the charts. The 3rd Officer must assist the 2nd Officer. On vessel's equipped with electronic notices to mariners such as Chartco, Digitrace or other, the chart correction log is to be maintained to identify the correction of CDs that have been applied.

Vessels subscribed to digital list of lights of Digitrace / Chartco form, should ensure that the latest updates had been uploaded into the system from the latest CD so the hard copies of the list of lights are not needed. The same goes with those ships that have Admiralty Digital Publications (ADP). The records of received corrections must be saved and no hard copies of publications should be kept on board.

If at any time the Notices to Mariners are not received, the Master must inform the office immediately. It shall be the Master's responsibility to ensure that the latest Notices to Mariners are on board within 3–4 weeks of the running weeks.

For vessels subscribed to Digitrace / Chartco, technical assistance must be sought immediately through the service provider. The Master has a full authority to obtain the Notices to Mariners locally through the agents or from the Harbour Master's office.

All efforts must be made to correct the passage charts, especially port approach charts, prior to sailing. Notices to Mariners must be retained on board either electronically on CDs or paper copies.

Passage charts must also be corrected to the latest temporary and preliminary notices. Vessels subscribed to electronic Notices to Mariners need not maintain separate register / file for filing the temporary / preliminary notices, however ships without Digitrace / Chartco should maintain the T & P file / register.

The T & P notice number and the week must be written in pencil in the bottom left-hand corner. The notices shall be filed area by area as per the annual summary of Admiralty Notices to Mariners. The T & P notice affecting voyage charts must be plotted on the chart in pencil. T & P notices file / records must be used in conjunction with the list of T & P notices published in the Annual Summary of Notices to Mariners.

Responsible officers should refer to the British Admiralty publication "How to Keep Your Admiralty Charts up to Date (NP 294)" for guidance on correction of charts and other Admiralty publications. It is recommended that Master sends the status of the last notice received on board on a monthly basis. It is usually the responsibility of the 2nd Officer to ensure that a continuous record of corrections done is available, including back-up arrangements in case if only soft copy of records is maintained.

In case of any new charts or publications are received on board, existing ones are to be cancelled, or deleted from the folio, the electronic notices service provider (Digitrace or Chartco) must be informed. This will enable them to ensure that the right corrections and tracings are being sent on board.

When the ship is subscribed to electronic notices / publications, and services, the following guidelines have to be noted:

- vessels do not need to order paper copies of the Annual Summary of Notices to Mariners, Weekly Notices to Mariners or cumulative notices as all these are already contained within the software;
- for vessels subscribed to using the digital list of lights, there is no need to order paper copies of the Admiralty List of Lights;
- the Digital List of Lights is the USA publication and is accepted worldwide in lieu of the Admiralty List of Lights;
- if vessel is using electronic version of CG 515 (Requirements of Administrative Committee of Federal Register (USA) 515), there is no need to order paper copies of CFR 33/CFR 46 or the MET 515. The supplier would send updates to CG 515 once every four months.

As a precaution / back-up, vessels can make multiple installations and a supplier will provide extra licenses for each installation at no additional cost. The vessel should then keep each installation up to date by using the updates via e-mail and CD.

Files containing port / navigation circulars sent on board must be maintained.

Official nautical charts can be either paper or electronic ones produced by or on the authority of a national hydrographic office. Official nautical charts can be in one of two electronic formats.

- Electronic navigational charts (ENC) are official vector nautical charts. When displayed on ECDIS equipment they are equivalent to paper charts.
- Raster navigational charts (RNC) are official raster nautical charts. The British Admiralty ARCS format charts and United States NOAA format charts are examples. However, when displayed on ECDIS or RCDS equipment, they do not have the same characteristics as ENC.[9]

To use ECDIS as a primary system without paper charts, two fully independent IMO type-approved vector chart systems are required. Master and all navigating officers on ships fitted with IMO approved and operational ECDIS as primary means of navigation shall have to receive formal training on the use of the ECDIS equipment ashore and hold the certificate.

Full use of the alarm systems shall be made in order to make a proper appraisal of the situation through quick and early warnings, e.g. spot soundings, contours, cross track, cross chart, etc. The manual must be consulted to understand the actions to be taken when the various alarms sound.

Alarm messages on the approach to special areas (TSS, anchoring prohibited, etc.) must be monitored. Limitations of the equipment, which are inter-phased with the ECDIS equipment, must be appreciated. In particular, the ship's position fixing systems must be properly monitored. Limitations of the primary position fixing systems must be known and when to switch over to the secondary position fixing system must be clearly understood.

Proper care must be taken with regard to this during coasting and shallow water passages. Caution must be exercised when using a radar overlay, as the picture on the ECDIS and the radar may not always match. Attention must be paid when target vectors are based on ship's speed through the water (from radar overlay) while ECDIS is exhibiting speed over the ground.

All the navigation sensors such as GPS, log and gyro are connected to provide positional information. As a part of integrated bridge system, an autopilot is also connected to ECDIS to provide an auto track control (providing automatic steering on autopilot panel by choosing "follow the track" option).

The recommended chart scales shall be used, though scanning of various scales may be done.

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[9] Bridge Procedures Guide, 3rd Edition, Witherby Publishers. 1998. p.51.

Raster charts are copies of the same paper charts, just electronic. It is done by digital scanning techniques and no data on raster charts can be layered. It is possible to load only one particular chart by selecting a particular one.

With regard to raster charts, the following additional limitations must be appreciated and considered:

- it is a chart-based system;
- it cannot be interrogated and hence, certain safety parameters are not selected;
- the alarms may not get triggered off by the chart data;
- excessive zooming may degrade the display;
- the chart may look cluttered.

Hence, an extra effort may be required to read and obtain information. The ECDIS equipment must be kept updated through corrections.

A record of all update CDs or folders containing correction (if received via e-mail) must be maintained on board. It may be inserted in the chart correction log for ease of reference.[10]

3.3.9. Automatic identification system (AIS)

The purpose of AIS is to improve safety of navigation by automatic information provision to ship and competent shore authorities.

An AIS satisfies the following functional requirements.

- Static: fixed data of vessel such as name, call sign, length, breadth, etc.
- Dynamic: real time information such as speed, course, etc.
- Voyage related: voyage specific data such as drought, cargo, persons on board, etc.
- Short safety related messages.

The latter ones are fixed or free type short text messages that can be addressed either to a specified vessel by MMSI number or to all ships in the area. Their content is related to safety of navigation. They do not in any way remove any requirements of GMDSS equipment. It is recommended that a record of received messages is maintained.

The voyage related data must be manually entered into the AIS before the beginning of every voyage or whenever changes occur. The static data can be checked once every voyage or once every month, depending on manufacturers' recommendations or company's policy. AIS must be in operation at all times except where protection of navigation information is required.

Action to avoid collision must be carried out in strict compliance with the COLREGs. There is no provision in the COLREGs for use of AIS information with a reason to determine the action to avoid collision, however AIS information can be used in combination with the other reliable information to detect risk of collision as it is said in Rule 5 "Lookout".

Once a ship has been detected, AIS can assist in tracking it as a target. By monitoring the information transmitted by that target, its actions can also be monitored. Changes in heading and course are immediately apparent and many of the problems common to tracking targets by radar, particularly clutter, target swap as ships pass close by and target loss following a fast manoeuvre, do not affect AIS.

AIS can also assist in the identification of targets by name or call sign, by ship type and navigational status. AIS information may be used only to assist in determining the risk of collision but not for sole decision making for collision avoidance. AIS is an additional source of navigational information. It does not replace but supports navigation systems such as radar target tracking and VTS.

[10] Shipboard Procedures, AESM. 2007.

There are some limitations of AIS, namely:

- AIS may not be functioning or may be switched off on some ships;
- the accuracy of AIS information received is only as good as the accuracy of the AIS information transmitted;
- poorly configured or calibrated ship sensors (GPS, log and / or gyro) might lead to incorrect information being transmitted.

To conclude, when using AIS, it is obligatory not to take AIS as a sole mean of collision avoidance. Every navigator must comply with the COLREGs.

AIS sensor is also connected to ECDIS and radar equipment to give full available information to a navigator at conning position.

Some local port regulations require “pilot plug” to be available with the AIS equipment. That means that when a pilot embarks the ship, he or she can connect to the “pilot plug” by their pilot navigational equipment to gain all necessary data for safe navigation of the ship.[11]

[11] Shipboard Procedures, AESM. 2007.

PART 4

●

ECDIS BASIC PRINCIPLES GUIDEBOOK

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ARVYDAS JANKAUSKAS

ABBREVIATIONS

AIS – Automatic Indentification System
ARCS – Admiralty Raster Chart Service
ARPA – automatic radar plotting aid
DGPS – differential global positioning system
DNC – digital nautical chart
DTM – datum
ECDIS – electronic chart display and information system
ECS – electronic chart system
ENC – electronic navigational chart
EPFS – electronic position fixing system
ETA – expected time of arrival
ETD – expected time of departure
GIS – geographic information systems
GNSS – global navigation satellite system
GPS – global positioning system
HCRF – Hydrographic Chart Raster Format (developed by UKHO)
HDG – heading
HDOP – horizontal dilution of precision
IMO – International Maritime Organization
MFD – multi functional display
PDOP – positioning (3D) dilution of precision
RAIM – receiver autonomous integrity monitoring
RCDS – raster chart display system
RNS – raster nautical chart
SCAMIN – scale minimum
SENC – system electronic navigational chart
STCW – the 1978 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW 78)
STW – speed through water
XTD – cross track distance
WPT – waypoint

INTRODUCTION

ECDIS methodological material is for navigators and students of Marine Navigation, to improve their understanding and facilitate safe and effective use of ECDIS. This methodological material was prepared in accordance with the requirements of international requirements set out in the following documents:

- STCW 78 A-II/1 "Use of ECDIS to maintain the safety of navigation";
- STCW 78 A-II/2 "Maintain the safety of navigation through the use of ECDIS and associated navigation systems to assist command decision making";
- IMO MSC.1/Circ. 1503/Rev.1 "ECDIS – Guidance for good practice";
- STCW 78 Chapter VIII "Standards regarding watchkeeping".

It is extremely important to set the appropriate safety settings on ECDIS for proper and reliable work of the system. With ECDIS, navigators must recognize the level of display and the objects to display for the optimum navigational information for any situation. It is essential that all navigating officers are aware of the benefits of managing the chart display, safety settings, and alarm system of ECDIS. Improper management of the system may result in grounding incidents.

This methodological material explains understanding and ability to interpret and react properly to all kinds of alarms and warnings of system data, charts, navigational sensors and indicators.

The ECDIS trainee should be able to do the following:

- operate the ECDIS equipment, use the navigational functions of ECDIS, select and assess all relevant information and take proper action in the case of a malfunction;
- assess and understand the potential errors of displayed data and the usual errors of interpretation;
- understand and explain why ECDIS should not be relied upon as the sole reliable aid to navigation.

4.1. ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEM (ECDIS)

This chapter describes the procedure used in the setting of safety parameters, the basic principles of the route planning and schedule in use of ECDIS.

The aim of this chapter is to provide the user with guidelines in the solution of various tasks, which may arise during the voyage, and to give the user some ideas of the operating principles and capabilities of ECDIS task.

4.1.1. Basic knowledge about ECDIS

An electronic chart display and information system (ECDIS) may be accepted if satisfying the chart carriage requirement of SOLAS regulation 19.2.1.4 and that system should conform to the relevant performance standards adopted by the IMO.

ECDIS should conform to the following IMO performance standards:

- if installed before 1 January 2009, should conform to Resolution A.817(19);
- if installed on or after 1 January 2009, should conform to MSC.232(82).

ECDIS under the IMO performance standards basically should:

- display SENC information;
- foresee provision and updating of chart information;
- display other navigational information;
- display visualization using adequate colours and symbols;
- be capable of displaying information for route planning and supplementary navigation tasks;
- perform route monitoring;
- perform route recording;
- have back-up arrangements;
- capable to operate from main and emergency source of electrical power.

The main benefit of ECDIS is to ensure the following abilities:

- reduce the navigational workload compared to using the paper chart;
- free the mariner for maintaining a proper and safe lookout and for collision avoidance;
- lighten the navigational situation monitoring;
- make easier the situation awareness and decision making;
- provide audio and visual alarms and warnings;
- inform about malfunction of the equipment;
- ensure voyage recording;
- have at least the same reliability and availability of presentation as the paper chart published by government-authorized hydrographic offices;

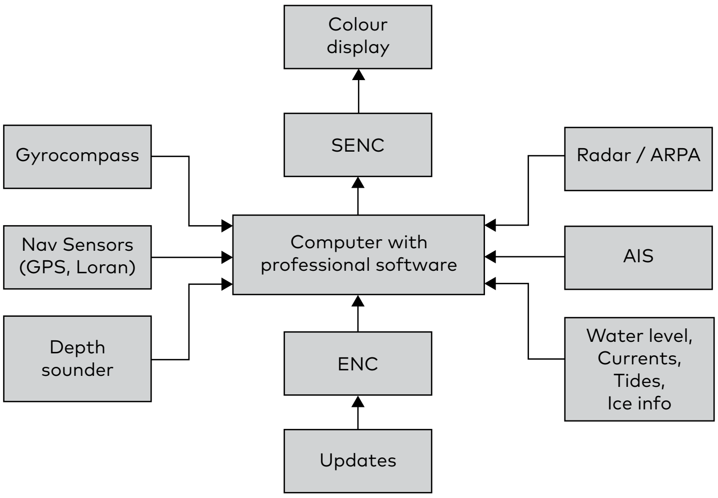


Fig. 4.1. *ECDIS composition (Jankauskas, A.).*

- enable the mariner to execute all route planning, route monitoring and positioning;
- enable the mariner to execute continuous plotting of the ship's position.

All Masters and Deck Officers of ships, which are fitted with ECDIS, should be familiarized with that system and have a thorough knowledge and understanding of safe and effective use of the system described in the IMO resolution MSC.1/Circ.1503/Rev.1. "ECDIS – Guidance for good practice" and take into account the provisions laid down in the 1978 STCW Convention on competence requirements A-II/1 and A-II/2.

The composition of ECDIS components is shown in Fig. 4.1.

4.1.2. Configuration of ECDIS safety parameters

ECDIS should be adjusted for proper use, taking into account the following safety items:

- dangers for navigation;
- obstacles of navigation;
- depth limits;
- under keel clearance;
- ship's routing recommendations;
- alarm settings.

The adjustment options can be found in the following Task List windows: Configuration, Charts, Monitoring and Navigation.

4.1.2.1. Configuration settings

Configuration panel allows to set measurement units, general setting, radar settings, time zone as well as obtain information about license validity and working status of the external devices.

During sailing along the monitored route, the ECDIS task provides **AutoZoom** function, which enables the automatic increase of scale as the next waypoint is approached. AutoZoom mode is available on dual panel only. Approaching the waypoint, the chart scale automatically starts zooming gradually to the adjusted value.

F-distance (forward distance) is an important value changing the course to the new route leg. It is a distance measured in metres – a straight line from the start of manoeuvre to the start of the turn. F-distance assures that the vessel will end up on the next course line with minimum deviation XTD. F-distance can be entered for three loading conditions: loaded, medium, and in ballast. It

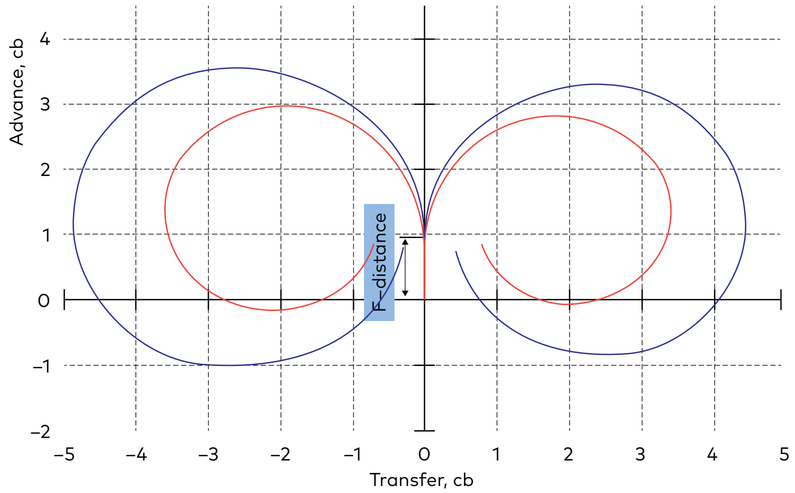


Fig. 4.2. *F-distance value on the ship's turning circle (TRANSAS LNG 14 full load manoeuvring characteristic).*

presents as wheel over line (WOL) on the route. The value can be set or changed only at the moment when no route is activated. On activation of the route for monitoring the value of F-dist is locked. In Fig. 4.2, it is shown how to find the F-distance value from manoeuvring booklet.

Display reset to function is used for setting the calculated screen redraw boundaries – percentage ratio of the screen length and distance from the ship symbol to the screen boundary (30–70 per cent).

The configuration adjustment options are shown in Table 4.1.

Table 4.1

Options of ECDIS Configuration Task (A.Jankauskas)

Performance	Item	Settlement / Entry
Task list ↓ config ↓ **units** →	Ship and target speed	knot, kn/kilometre per hour, km/h
	Distances	Nautical mile, NM / kilometre, km / statute mile, stm / hectometre, hm
	Precision distances	Metre, m / feet, ft / yard, yrd
	Depth / height	Metre, m / feet, ft / fathom, fm
	Draught	Metre, m / feet, ft
	Wind speed	Metre per second, m/s / knot, kn / Kilometre per hour, km/h
	Temperature	Degree Celsius, °C / Degree Fahrenheit, °F
Task list ↓ config ↓ **General** →	Palette	Daylight / dusk – night with moon / night – moonless night / night inverted – moonless night, text inverse colour
	Timer warning	Every X min / at specified date and time / OFF
	End of watch alarm	X minutes before end
	Chart panel cursor	Short / long
	Docking mode (DM) settings (DM works in "Dual")	Initial scale (1:7500 and larger)
	AutoZoom settings (AZ works in "Dual")	Maximum scale and time of update (seconds)
	Display reset to	from 30 to 70 percent
	Ship history (in docking mode)	Steps – from 1 to 15 symbols Interval – from 1 to 30 seconds.
	Forward distance (F-dist)	Loaded / medium / in ballast (before route activation)
Task list→ config↓ →tme zone→	Current time zone settings	UTC time / ship's time / time zone
	Schedule time zone change	Change at ship's time / new ship's time will be / new time zone will be

4.1.2.2. Chart settings

All settings on the chart panel, which can be found in the task list (General, Layers and ENC windows), are related with chart visualization on the display. For continuous operation of ECDIS on the display the most suitable chart for this area should be presented. There are three selections of loading charts.

- **Chart autoload ON** allows automatic uninterrupted display of the chart taking into account the setting of autoscale and chart priority.
- **Chart autoload FIX** allows to fix the present chart till it's boundary. The chart autoloading is disabled. After the ship symbol has passed the boundaries of the fixed current chart, the autoloading mode will be turned on automatically.
- **Chart autoload OFF** is a manual method of chart loading. It requires the operator to select the charts himself / herself from the chart list using "Complete list" or "By position" window. If no chart is selected, no chart will be presented and will be displayed as shown in Fig. 4.3.
- **Chart autoscale** allows to load the next one with the following assigned scale ratio values:
  - 0 , original scale;
  - from −1 to −5, decreased scale;
  - from +1 to +5, increased scale.

ENC charts have a feature to show or hide some information, which can prevent us from overloading the chart with excessive data. We can reduce the displayed information overloading by configuring the chart layers selecting the display type Base, Standard, Custom, or All. Thus we can switch off unnecessary visualization. The Base configuration should not be used for navigation. As a minimum the Standard display should be used as the display on ECDIS for navigation purpose.

The ECDIS task gives opportunity to set the priority loading of different format charts.

- **None** – the system allows to load all the charts from the collection in any format, which are equally suitable for use.
- **ENC** – the ENC format (S-57) vector chart among different formats will be loaded, if it is available under the ship's position.
- **DNC** – the DNC format vector chart among different formats will be loaded, if it is available under the ship's position.
- **HCRF** – the system will check for ARCS format raster charts.

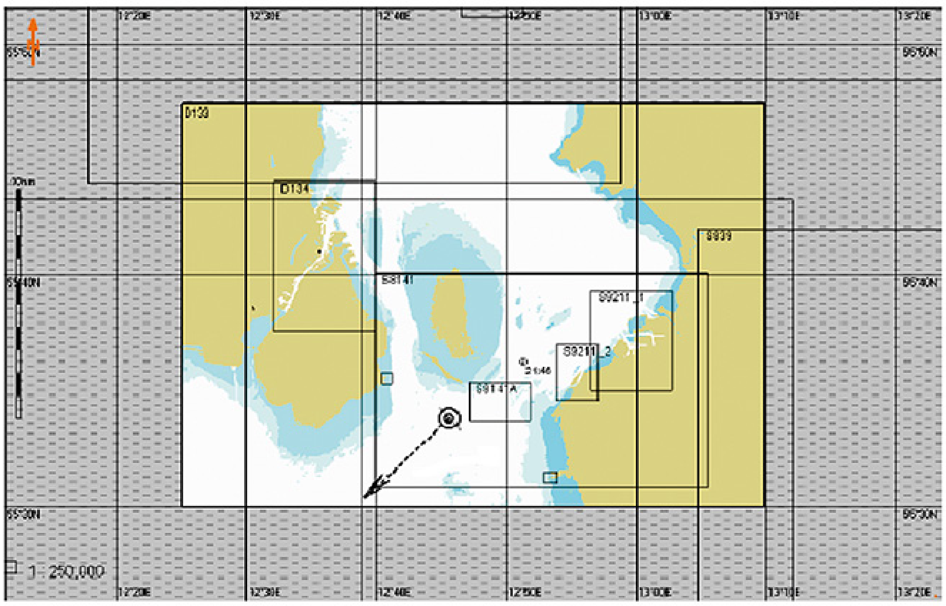


Fig. 4.3. *Chart's presentation with Autoload OFF (TRANSAS NTPro 5000).*

Chart tasks also provide a possibility to adjust depth presentation on the display.

- **Spot soundings to...** – enter the value and on charts will be displayed all depths the values of which are smaller than the setting made. If the setting is "0", all the soundings are displayed.
- **Shallow contour** – enter the value of the deep water contour delineating the colour highlighting the shallow area for ENC format charts.
- **Deep contour** – enter the value of the shallow water contour delimiting the colour highlighting the deep water area for ENC format charts.

The following windows are used for information only and can be adjusted on the monitoring panel.

- **Safety depth** – to display the safety depth value for vector format chart.
- **Safety contour** – to display the safety contour value for vector format chart.

A depth equal to or less than the "Safety depth" is highlighted on the ECDIS task screen in bold type when the display of spot soundings is turned on.

We should bear in mind that if the depth contour specified by the user is not digitised on the chart, the next deeper digitised contour available on the chart will be accepted as the safety contour and will be displayed as a bold line. In Fig. 4.4, it is shown how the system takes into account user's entry "Safety contour" 15 metres – instead of that 20 metre contour is highlighted on the display. Depths are highlighted as prescribed values.

The appropriate Safety Contour and Safety depth value based on the ship's draught and UKC requirements after considering the accuracy of the ENC and the expected conditions to be encountered on the passage in worst case scenario can be set as follows (depends on the company's requirements).

- Deep sea: draught + squat at maximum speed + 50 % of the maximum draught + various factors (dynamic change) to calculate UKC.
- Shallow water: draught + 10 % of maximum draught or 1 metre (whichever is greater) + various factors (dynamic change) to calculate UKC.
- Within port limits: draught + squat at maximum speed + 1.5 % of the ship's breadth + various factors (dynamic change) to calculate UKC.

Shallow contour may be set to the same value as the safety contour or may be set to a lower valued contour to allow the navigator to distinguish the depth

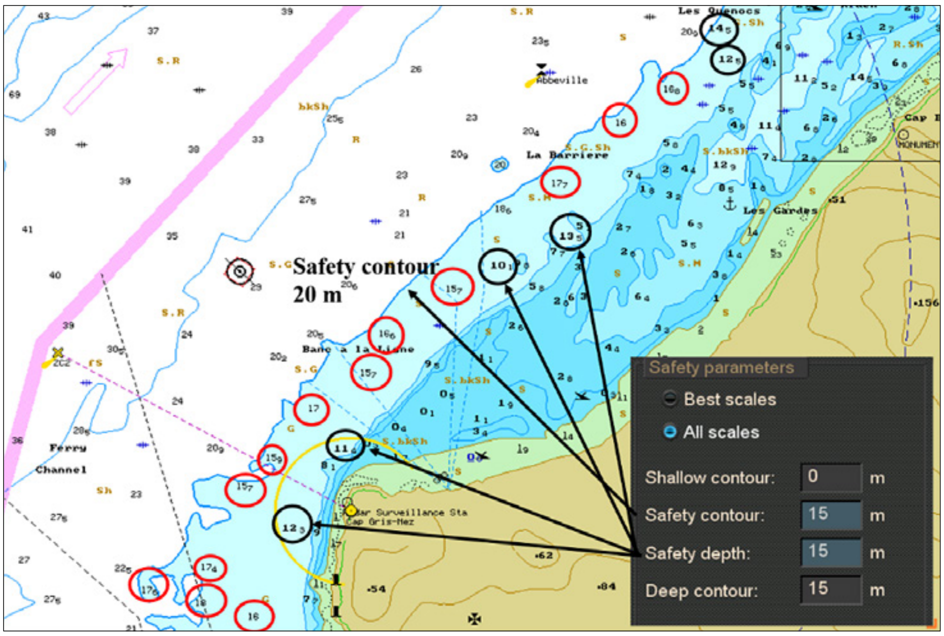


Fig. 4.4. *Safety contour and safety depth (TRANSAS NTPro 5000).*

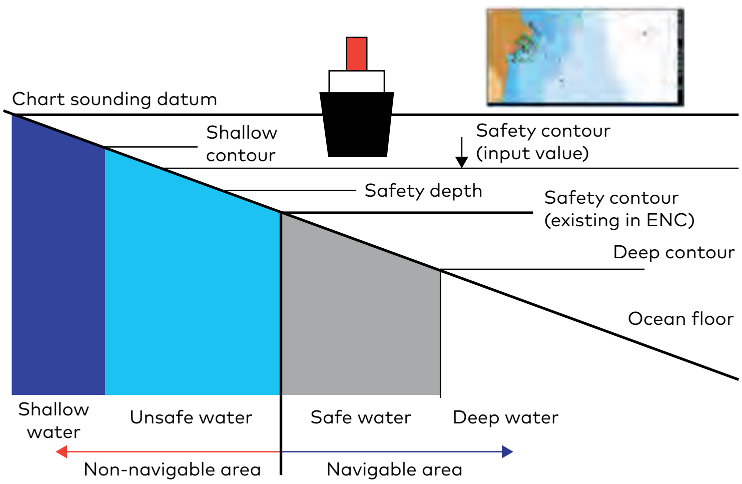


Fig. 4.5. *Navigational and non-navigational areas (TRANSAS ECDIS Workbook).*

gradient of the waterway. Deep contour may be set as a depth of water when squat is likely to be experienced, it should be set equal to twice the vessel's static draught. The main principle of understanding of navigational and non-navigational areas is shown in Fig. 4.5.

After activating the **four shades** mode, the display related shallow and deep contour will be shown as two additional blue coloured patterns on the chart panel, as shown in Fig. 4.6.

The SCAMIN or minimum scale attribute of an object determines the display scale below which the object must no longer be displayed, in order to reduce clutter (see Figs. 4.7 and 4.8). In setting this level, the producer should consider both clutter and the scale at which the object is no longer likely to be necessary for navigation. The most widespread use of SCAMIN involves the decisions by ENC producers on what should be the density level for individual spot soundings.

Chart adjustment options are shown in Table 4.2.

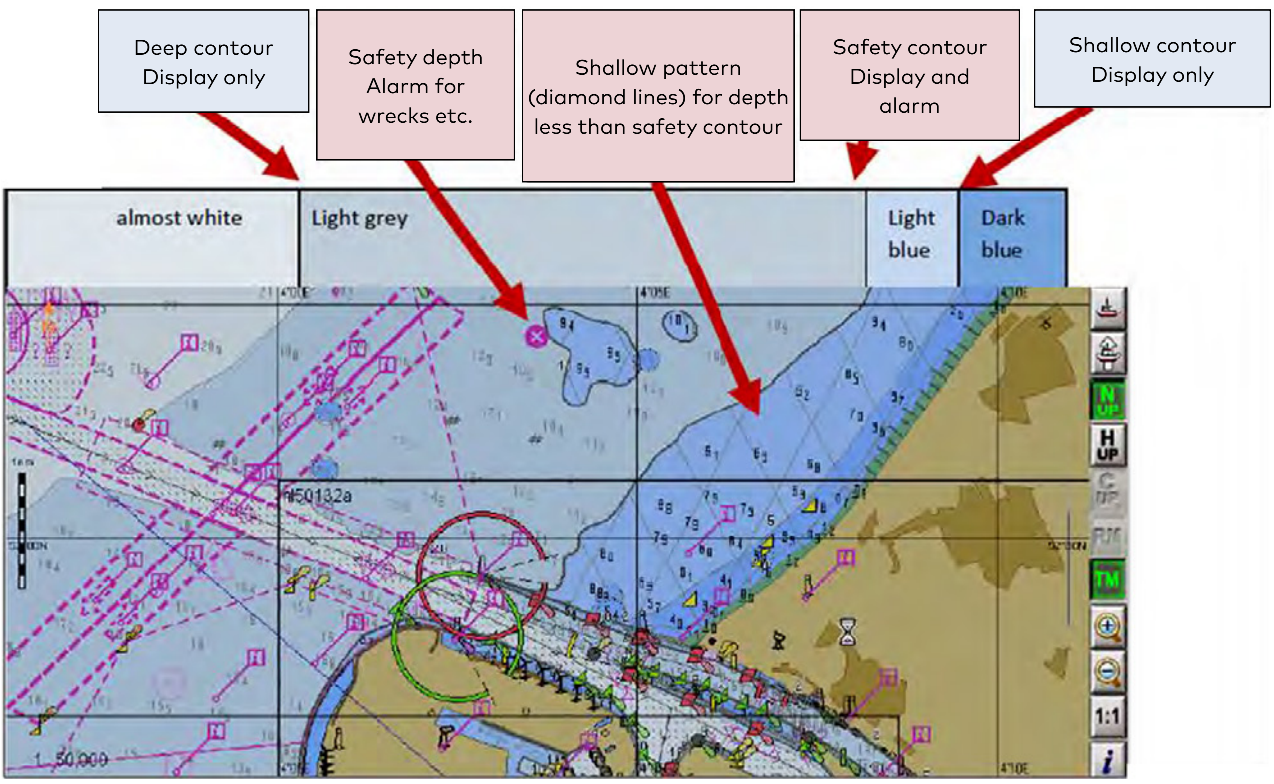


Fig. 4.6. *Four shades visualization (TRANSAS ECDIS Workbook).*

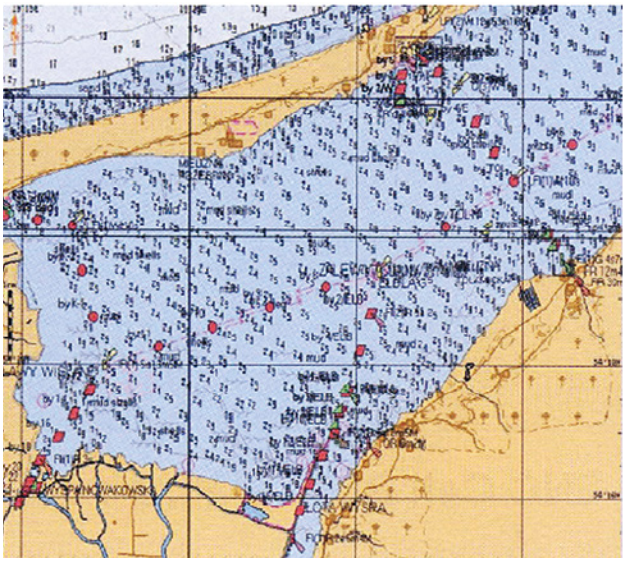


Fig. 4.7. *SCAMIN not used (ENC Zalew Wislany).*

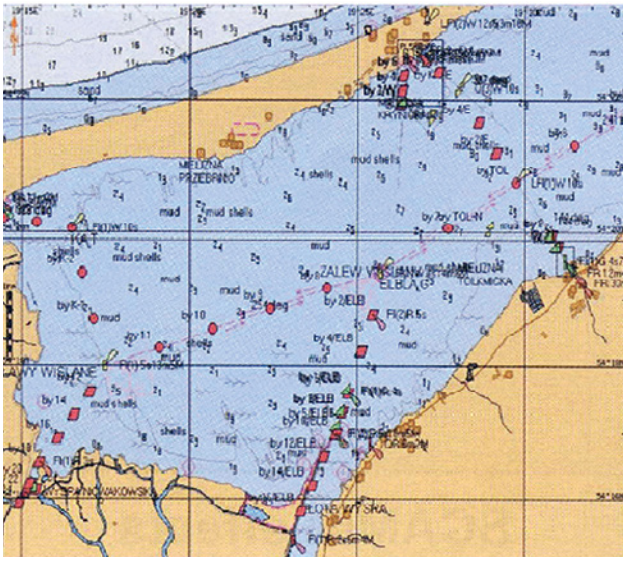


Fig. 4.8. *SCAMIN used (ENC Zalew Wislany).*

Table 4.2

Chart Adjustment Options (Jankauskas, A.)

Performance	Item	Entries / options
Task list→ charts ↓ →**general**→	Chart autoload	ON / OFF / FIX
	Chart autoscale	from –5 to +5
	Chart priority	None / ENC / DNC / HCRF
Task list→charts ↓ →**layers**→	Display category	Base / standard / custom / all
	Show / hide display information	Spot soundings to... (value) Isolated dangers / cables, pipelines / names / other information / all depth contours / seabed / buoys' names / scale bar / grid lines / chart boundaries / NAVTEX
Task list→charts↓ →**ENC**→	Areas	Plain / symbolised
	Points	Paper chart / symbolised
	Shallow contour Deep contour	Set appropriate value depending on relation to draft and depth
	Four shades Shallow pattern Use SCAMIN Full light lines Highlight info Show correction M-quality objects National names Show outdates	ON / OFF Show all / hide all

4.1.2.3. Monitoring settings

The monitoring settings can be adjusted by selecting the appropriate line of task list menu. There are three windows: Route Monitoring (see Fig. 4.9), Safety Alarms (see Fig. 4.10) and Navigational Alarms.

In the Route Monitoring window we can load / unload route and schedule, switch ON / OFF auxiliary information – XTD lines, course records on each leg, WOL, turn radius. When monitoring the passage, we can change from auto waypoint selection and turn radius value to manual setting on our request.

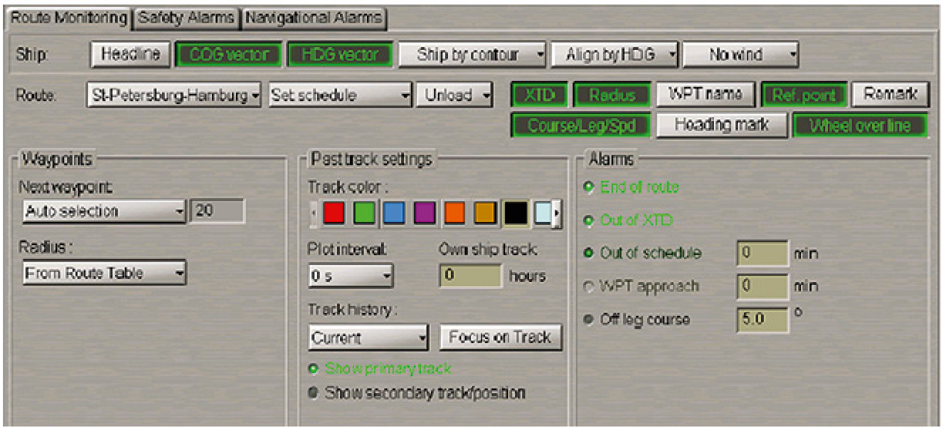


Fig. 4.9. *Monitoring of Route Monitoring window on task panel (TRANSAS NTPro5000).*

When sailing according to schedule along the planned route, the system will warn the user about approaching to the next route leg, deviation from course and schedule.

The Safety Alarm window allows to set safety frame values. It is not necessary to make this frame visible. The system will warn by automatically taking into account the user's settings about all dangers, which are passing the boundary of the frame, as shown in Fig. 4.11.

The following Safety frame settings are recommended for use, see Table 4.3.

Safety contour and safety depth settings are described in the Chart in Section 4.1.2.2.

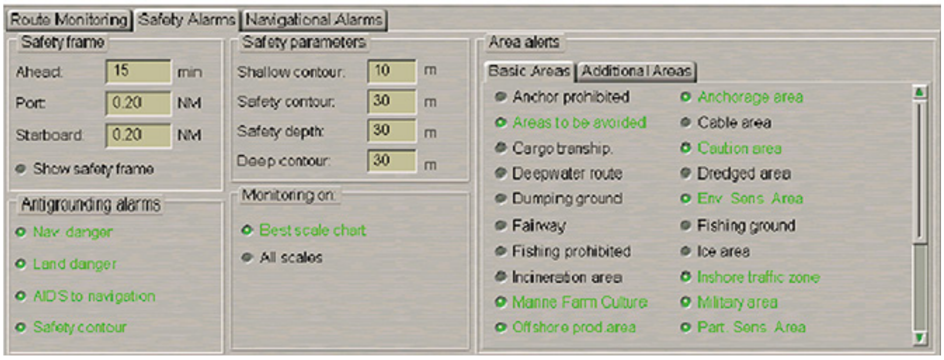


Fig. 4.10. *Monitoring of Safety Alarm window on task panel (TRANSAS NTPro5000).*

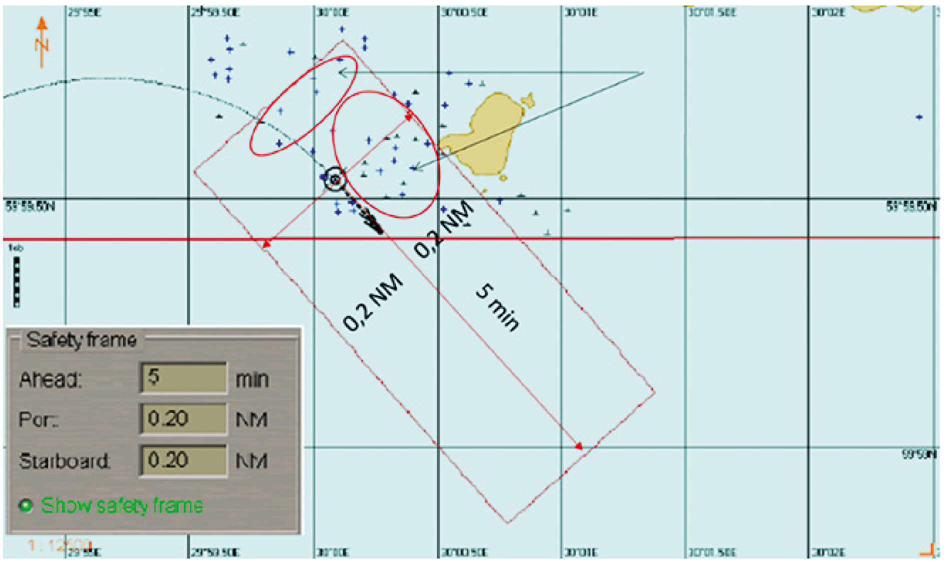


Fig. 4.11. *Safety frame presentation (Transas NTPro 5000).*

Table 4.3

Recommend Safety Frame Settings (Scorpio Ship Management)

Safety frame	Deep sea / open ocean	Coastal waters	Pilotage / confined waters
Ahead	15 min	12 min	3 min
Port	0.2 NM	0.1 NM	0.1 NM
Starbord	0.2 NM	0.1 NM	0.1 NM

Area alerts consist of Basic and Additional Areas for the selection of dangers-to-navigation. The bigger the selection, the more alerts there are. If some dangers are unnecessary, they can be switched off.

The Sounder group is used for turning on the monitoring of the echo sounder readings and contains the following checkboxes.

Fig. 4.12. *Sounder alarm window (TRANSAS NTPro 5000).*

Table 4.4

Options of Monitor Settings (A.Jankauskas)

Performance	Item	Entries / options
Task list ↓ monitoring ↓ **route monitoring →**	Ship	ON / OFF: headline / COG vector / HDG vector, ship by contour / symbol, wind vector / wind card
	Route	Load/ unload Route and Schedule ON/OFF: XTD, arrival circle, radius, WPT names, course / leg / speed, heading mark
	Waypoints	Next waypoint: auto selection or manual selection radius of turn – from route table or manually
	Past track settings	Track colour and plot interval: 0 / 10 s / 1 min Own ship track: 0÷24 H Track history: current or of specified date ON / OFF: show primary track / show secondary track
	Alarms	ON/OFF: end of route / out of XTD, out of schedule [x] min, WPT approach [x], min, off leg course [x] degr
Task list ↓ monitoring ↓ **safety alarms →**	Safety frame	Ahead – [x], min (from 1 to 15 min) Port and starboard – [x], NM (from 0.1 to 4.0 NM) Show safety frame – ON / OFF
	Antigrounding alarms	ON / OFF: navigational and land danger, aids to navigation safety contour
	Safety parameters	Safety contour and safety depth
	Area alerts	ON / OFF: sensors from Basic and Additional Areas list
Task list ↓ monitoring ↓ **navigational alarms →**	Primary / secondary diff.	Set [value], NM
	Chart	ON / OFF Off chart alarm
	Anchor watch settings	Bow and stern ring [x], m ON / OFF: anchor watch ring and alarm
	Sounder	ON / OFF: sounder depth [x], m and sounder alarm

Sounder depth – to enable and enter the minimum depth value (under keel clearance – UKC) for a warning generated upon the reception of data from the echo sounder; minimum depth determines the depth compared to the sounder readings. As a depth smaller than the set value is received from the sounder, the "Sounder depth" warning is generated, see Fig. 4.12.

Sounder alarm – to enable / disable the Sounder: no input warning.

UKC value should be taken into account in the company's guidelines and may be set as follows.

- Deep sea: minimum 50 % of maximum draught.
- Shallow water: minimum 10 % of maximum draught or 1 metre (whichever is greater).
- Within port limit: charter party, port and company requirements.

The full extended list of Monitor settings are shown in Table 4.4.

4.1.2.4. Navigation setting

For continuous ship's position monitoring, it is necessary to choose the primary and secondary position source in the Ship Position window of the Navigation task panel, see Fig. 4.13.

EPFS – DGPS, GPS and other similar systems.

DR – dead reconing – simple position calculation taking into account three component information: speed, time and distance.

EP – estimated position – advanced calculation taking into account speed, time, distance and drift.

ER – echo reference – position obtained by bearing and distance from radar reference object.

The Heading window of the Navigation panel (see Fig. 4.14) is used to activate the ship's heading source – gyro or magnetic compass. Gyro heading is corrected by entering gyro error. Magnetic heading is corrected by activating the auto variation from chart or entering it manually.

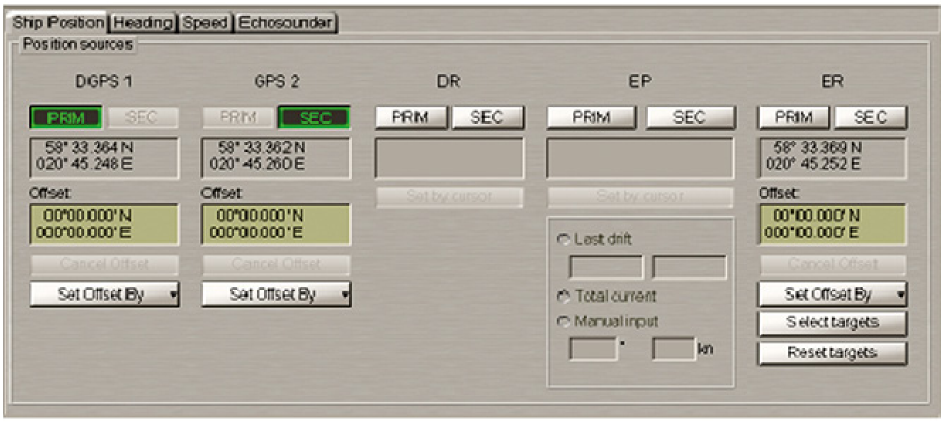


Fig. 4.13. *Navigation task panel (TRANSAS NTPro 5000).*

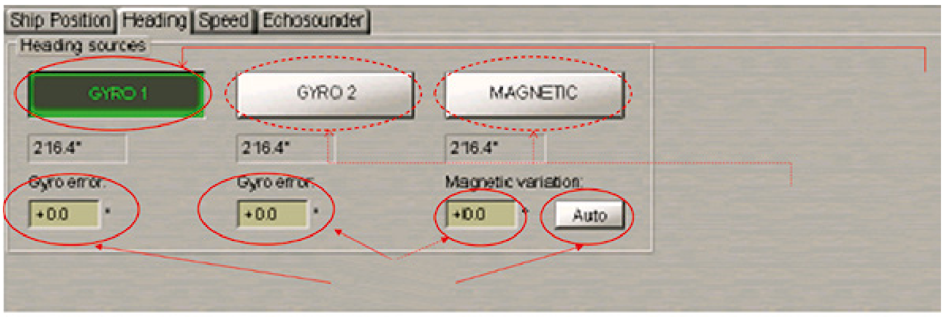


Fig. 4.14. *Heading source setting (TRANSAS NTPro 5000).*

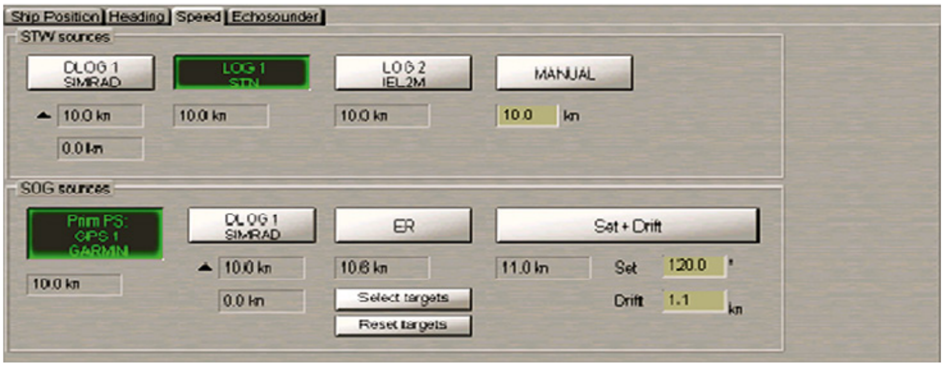


Fig. 4.15. The Speed window of Navigation panel (TRANSAS NTPro 5000).

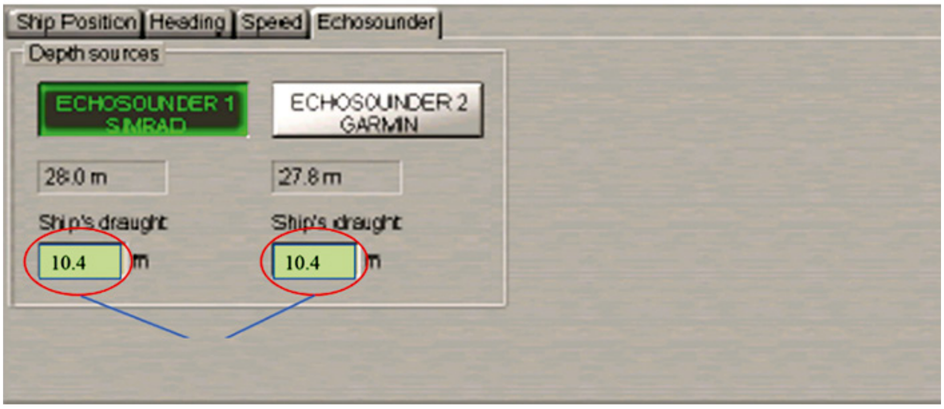


Fig. 4.16. The Echo-sounder window of Navigation panel (TRANSAS NTPro 5000).

The Speed window of Navigation panel (see Fig. 4.15) is used for the selection of speed through the water (STW) and speed over ground (SOG) sources.

Doppler Log (DLOG) is a source for display of longitudinal and transverse information of speed.

Log (LOG) is a source for displaying STW value from the Log.

Echo-sounder window (see Fig. 4.16) shows all connected depth sensors. Activate one of them and enter the ship's draught value for each to get correct information from the selected source.

Navigation setting options are shown in Table 4.5.

Table 4.5

Options of Navigation Settings (A.Jankauskas)

Performance	Item	Entries / Options
Task list→navigation↓ **ship's position→**	DGPS / GPS DR (dead reconing) EP (estimated position) ER (echo reference)	Primary- PRIM or / Secondary – SEC. It is recommended to monitor the ship's position by means of two different types of positioning. Enter offset if it is necessary.
Task list→ navigation↓ **heading→**	Heading sources	Gyro/Magnetic compass. Gyro error (manually). Magnetic variation (manually or auto).
Task list→navigation ↓ **speed→**	STW sources	DLOG / LOG / MANUAL
	SOG sources	PrimPS GPS / DLOG / ER / Set + Drift
Task list→ navigation↓ **echo-sounder→**	Depth sources	ECHO-SOUNDER 1 / ECHO-SOUNDER 2. Ship's draught (manually).

4.1.3. Handling of routes and schedules

A detailed voyage or passage plan should be prepared for the entire route from berth to berth in accordance with IMO Resolution A.893(21) "Guidelines for Voyage Planning".

The voyage planning and execution consists of the following stages:

- route planning (create new or modify the existing route);
- route checking;
- schedule creation;
- schedule calculation;
- route and schedule activation;
- route monitoring;
- route modification.

4.1.3.1. Route planning

Nautical navigation system ECDIS provides the following possibilities:

- to create a new route and save further use;
- to load, edit and delete already created route;
- to reverse the route;
- to merge selected routes into one;
- to check the route taking into account the facility's adjustments for dangers to navigation;
- to create and edit the route schedule.

Route creation function can be found as follows.

- Task List→Route Editor or Advanced Planning.

Route elements which should be entered are the following:

- waypoints' positions (latitude and longitude);
- waypoints' names (optional);
- route leg type (rhumb line – RL or great circle – GC);
- safe zone (cross track distance – XTD to the left / right side of the route);
- turn radius – from the table of manoeuvring characteristics or suitable for the route;
- wheel over line (WOL) is a line upon crossing from which it is necessary to start turning the rudder changing course to the next leg, taking into account F-dist, see Fig. 4.17;
- the route name.

Waypoints can be entered in the following ways:

- manually (digitally) – entering them in the route editor table;
- using the graphic editor – moving the cursor to the appropriate position;
- using tabular method – by entering them in the Position window, see Fig. 4.18.

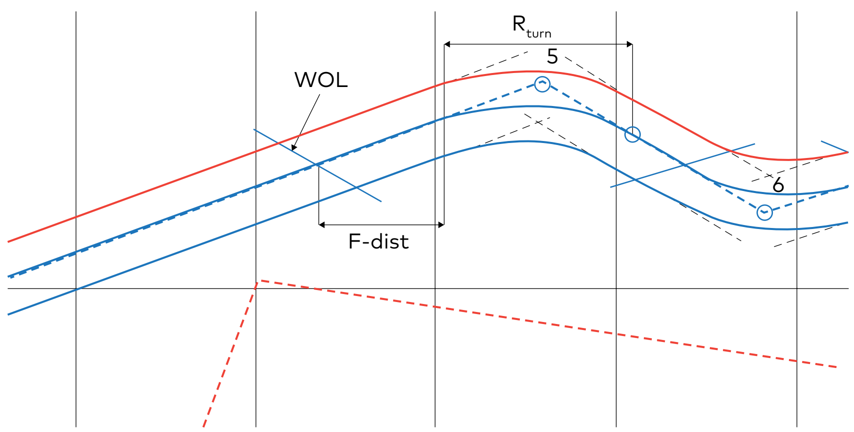


Fig. 4.17. *Prediction of turning (TRANSAS NTPro 5000).*

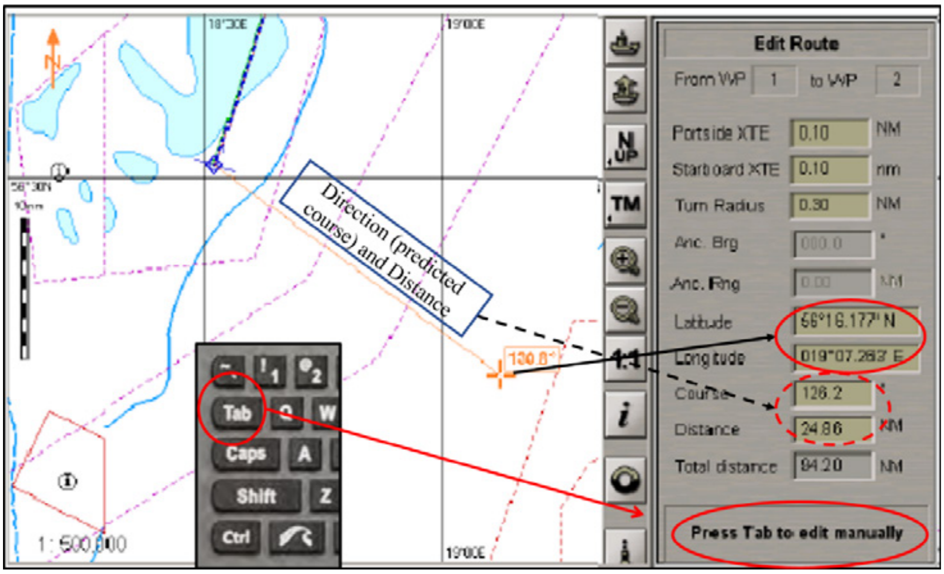


Fig. 4.18. *Tabular method of entering the position (TRANSAS NTPro 5000).*

4.1.3.2. Route checking

After the completion of route planning, it is required to check it for the following elements:

- safety parameters (user's settings on the Safety Alarms page of Monitoring panel);
- dangers to navigation;
- under keel clearance (UKC);
- tides and currents;
- reference points for the course change monitoring (if available).

The route checking can be performed as follows.

- Advanced planning→Waypoints→Check route, see Fig. 4.19;
- Advanced planning→Extra data→Voyage plan→Data collection, see Fig. 4.20.

The safety check will be made using your safety parameters and pre-programmed manoeuvring parameters. If during the check some warnings or dangers are found, all detected alarms along the route should be reviewed and corrected if necessary. Save any changes after the completion of checking or after the change of the route or some elements.

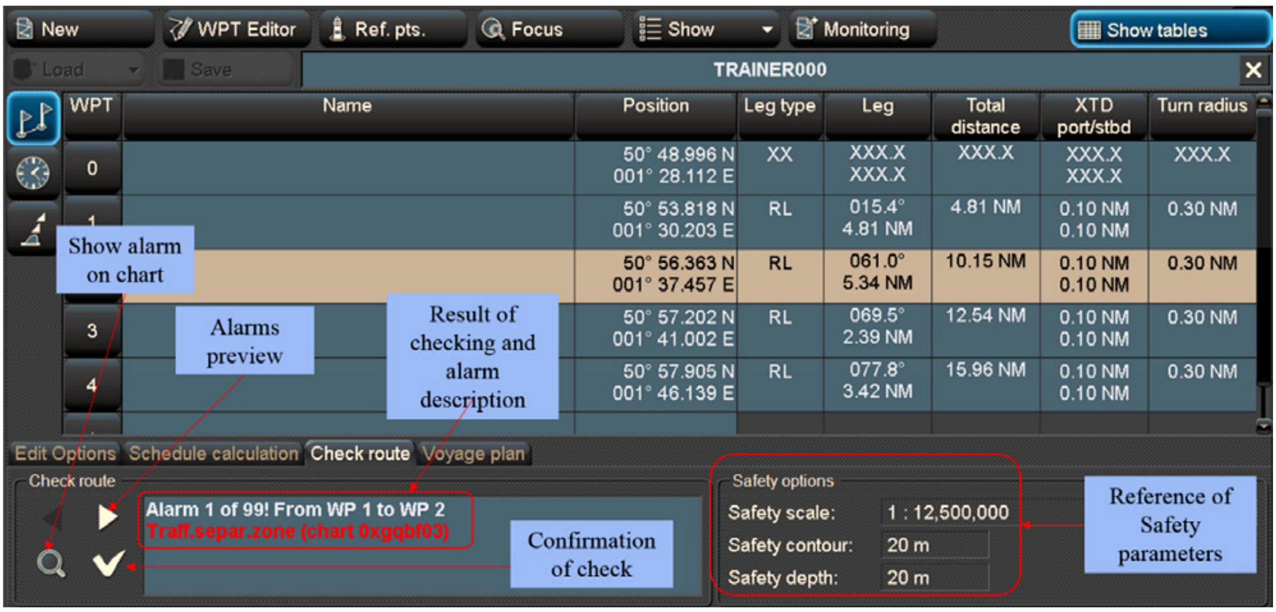


Fig. 4.19. *Route planning panel – route checking (TRANSAS NTPro 5000).*

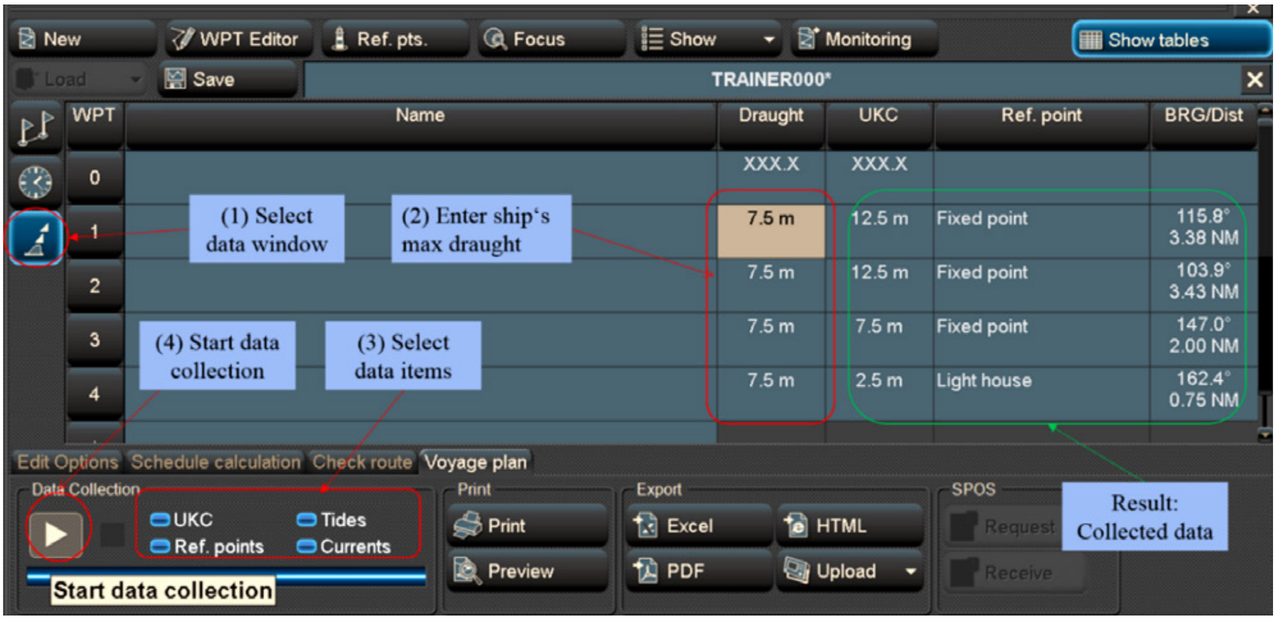


Fig. 4.20. *Route data collection window (TRANSAS NTPro 5000).*

4.1.3.3. Schedule creation, calculation and monitoring

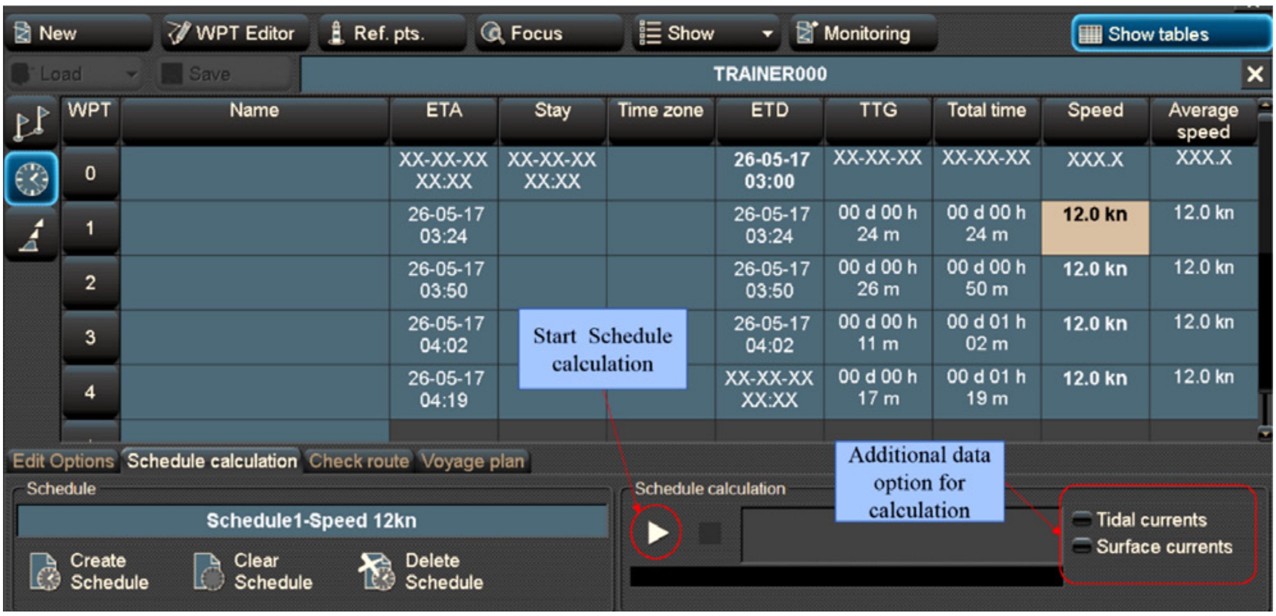
After the completion of the route planning, it is recommended to create an appropriate schedule or schedules for the purpose to execute effective monitoring, see Fig. 4.21.

Depending on the initial data, the following three types of schedule for the motion along the route can be created:

- ETD and speed on each route leg (speed);
- ETD and ETA (+ stay) in the route start and end points;
- combined schedule – with the set speeds (speed) and ETA in the selected intermediate WPT's.

Several schedules can be created for the same route with own prescribed name and these schedules can be activated or changed at any time of proceeding. When the appropriate schedule is assigned on the monitor's panel, it is recommended to call on the display the schedule monitoring window, see Fig. 4.22. If ETA information is displayed in red, it means that we are out of schedule and warning is generated. In this case we can use the

Fig. 4.21. *Route schedule calculation window (TRANSAS NTPro 5000).*



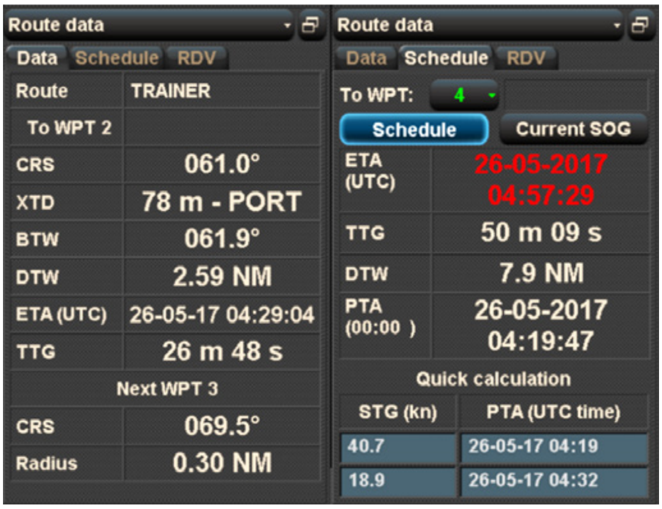


Fig. 4.22. *Route data display window (TRANSAS NTPro 5000).*

"Quick calculation" tool to calculate the new speed or alternative ETA from the ship's present position.

When creating the sailing schedule, the following elements should be taken into account:

- ETD and ETA;
- stay – time of stay in a WPT;
- time zone – for each WPT where it is necessary to take it into account;
- speed – the same for all route or different for each leg.

In case the vessel is out of schedule and the time of Out of Schedule is exceeded, the PTA data becomes red and warning is generated. In that case the Quick calculator helps to calculate the new speed from the ship's present position.

4.1.4. Ship's positioning

Ship's positioning settings should be adjusted in Navigation panel. In this panel, the window Primary and Secondary positioning system can be selected. It is recommended to always have two types of positioning sources. The most accurate system should be used for Primary positioning, i.e. DGPS, GPS, GLONASS or other available GNSS. Secondary positioning is used for control and backup.

4.1.4.1. Primary positioning

For primary positioning in the Navigation panel we can select the following:

- GPS / DGPS or similar GNSS;
- Dead reconing (DR);
- Estimated position (EP);
- Echo reference (ER).

Usually we choose GPS / DGPS or similar EPFS as primary and most accurate positioning method. It is very important to bear in mind the following:

- every equipment or system has an accuracy limit and in some areas, i.e. military or secret regions, the system signals can be blocked or accuracy changed;
- a satellite receiver needs to receive signals at least from 4 satellites to calculate the position, height and time;
- with signals from 5 or 6 satellites it may perform basic satellite error checks (RAIM). The more satellites, the better and more reliable is the information;
- HDOP should vary between 0.5–2 and normally not exceed 4, i.e. the spread of satellites over the sky;

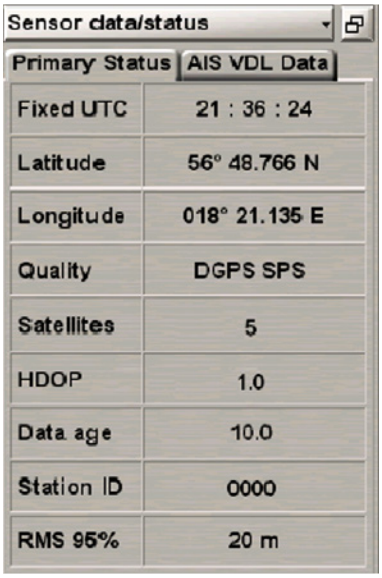


Fig. 4.23. *Ship's GNSS position status (TRANSAS NTPro 5000).*

- accuracy and reliability will improve with more satellites available and with these satellites well spread over the sky (HDOP);
- PDOP ≤ 6 (positioning (3D) dilution of precision);
- with GPS you should normally have 5–12 satellites always visible anywhere in the world.

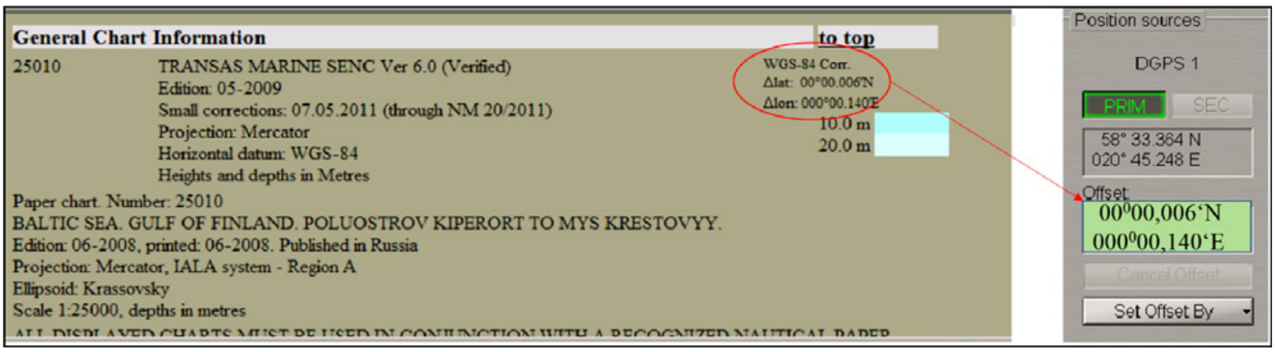
The position reliability status can be checked on the Sensor data display window. In Fig. 4.23, we can find the following important data about the status and accuracy of the position:

- the position fix time by GNSS;
- coordinates;
- number of used satellites (5 satellites);
- spread of satellites over the sky HDOP (good);
- data age – elapsed time from the last differential correction (1 sec.);
- Differential station used – No. 0000
- Expected position accuracy with 95 % – 20 metres;

Additionally, it is necessary to check the chart information for the position offset. We can get the chart information using tool "**i**" (*info*). Detailed information about the chart is presented in Fig. 4.24.

If a constant-value error is identified in the chart info, it can be taken into account entering correction value for EPFS in the window "Position offset". If there is an offset to the ship position coordinates, the window displays corrected coordinates and a special symbol – a red triangle. As a free cursor is positioned on this triangle, the correction value is displayed on the pop-up prompt window.

Fig. 4.24. *Primary position correction (TRANSAS NTPro 5000).*



In case of failure of primary position source, the Secondary becomes primary, if the Secondary was activated. If no Secondary position system was chosen, the ECDIS stops position calculation.

4.1.4.2. Secondary positioning

In addition to primary positioning in the Navigation panel, we can select secondary positioning. It ensures uninterrupted position tracking. In case of failure of primary positioning system, the secondary automatically becomes primary. If no secondary source is selected, ECDIS loses the ship's position and probability of an accident arises.

Echo reference is the most suitable method when sailing in coastal waters. This method checks the ship's position by the bearing and distance from selected stationary object.

Estimated position is computer calculated based on the data on the ship's speed, time and wind and current drift, or entered manually.

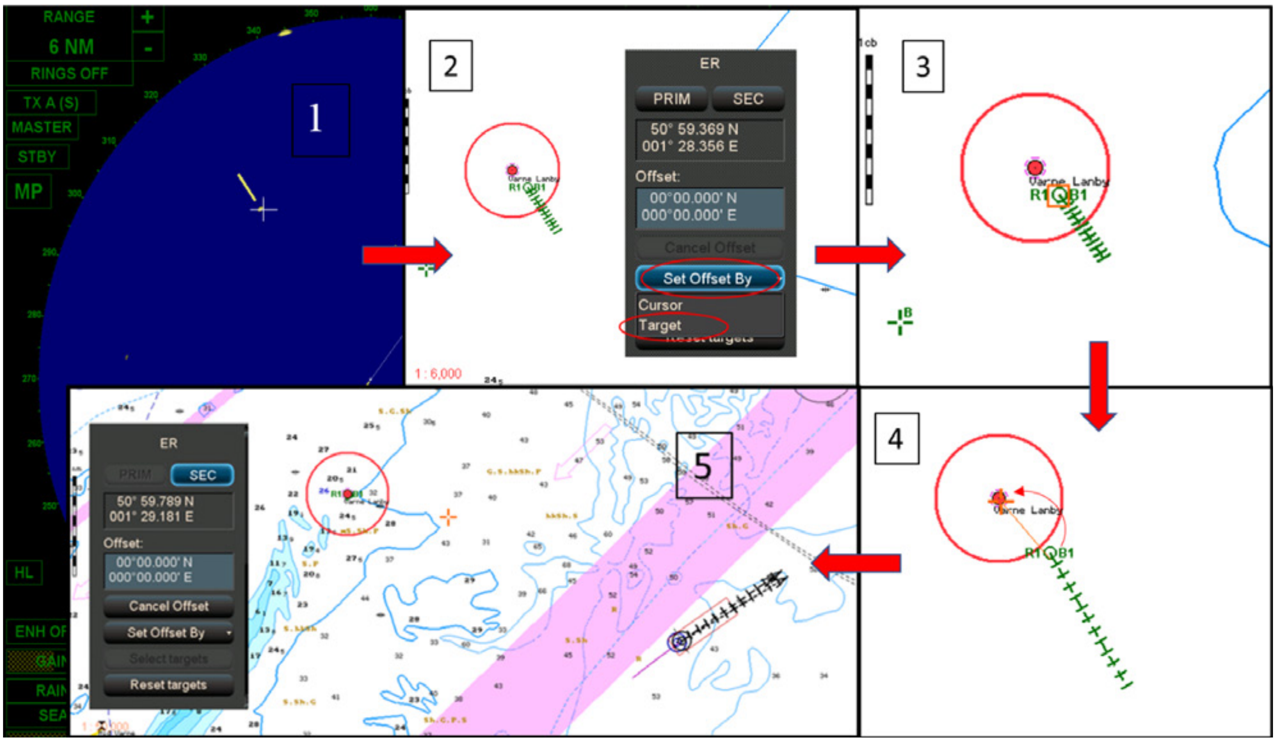
Dead reconing (DR) is the simplest calculated position obtained from the gyro and log by the ship's speed and time.

After choosing DR, EP or ER positioning method, further calculation starts from the ship's present primary position. The most reliable method comparing with GNSS is ER.

The sequence of echo reference positioning is as follows (see Fig. 4.25).

- Switch ON the radar.
- Press the ARPA button in the top part of the control panel to turn on the display of targets.
- Find and identify fixed, well visible object or objects on the radar.
- Acquire targets on the radar and wait until they are calculated (approx. 1 min.).
- In the Navigation window find ER and press Select targets button.
- Position the free cursor on the tracked target, which will serve as a reference point.
- Press the left trackball button. Index "R" will show up next to the reference point. Set the necessary number of reference points (up to 5).

Fig. 4.25. *ER positioning procedure (TRANSAS NTPro 5000).*



- To use the position determined with the aid of reference points in **ER** group, press **PRIM** or **SEC** button.
  - Check if the target's echo position and object's position on the chart is the same without deviation. YES – take into account ER position for monitoring.
  - NO – carry out the set offset procedure as follows:
    - ✓ press Set Offset by button;
    - ✓ choose Target;
    - ✓ position the free cursor on the tracked target;
    - ✓ press the left trackball button and drag the tracked target to the true position on the chart.

4.1.4.3. Manual position fixing

The ship's position should be monitored and checked continuously, even when using ECDIS. The **manual position fixing** method enables to plot lines of position (LOP) by measuring bearings and / or distances to visible objects, which are seen visually or on the radar. When measuring bearings, do not forget to correct them with compass error, and plot only true bearings.

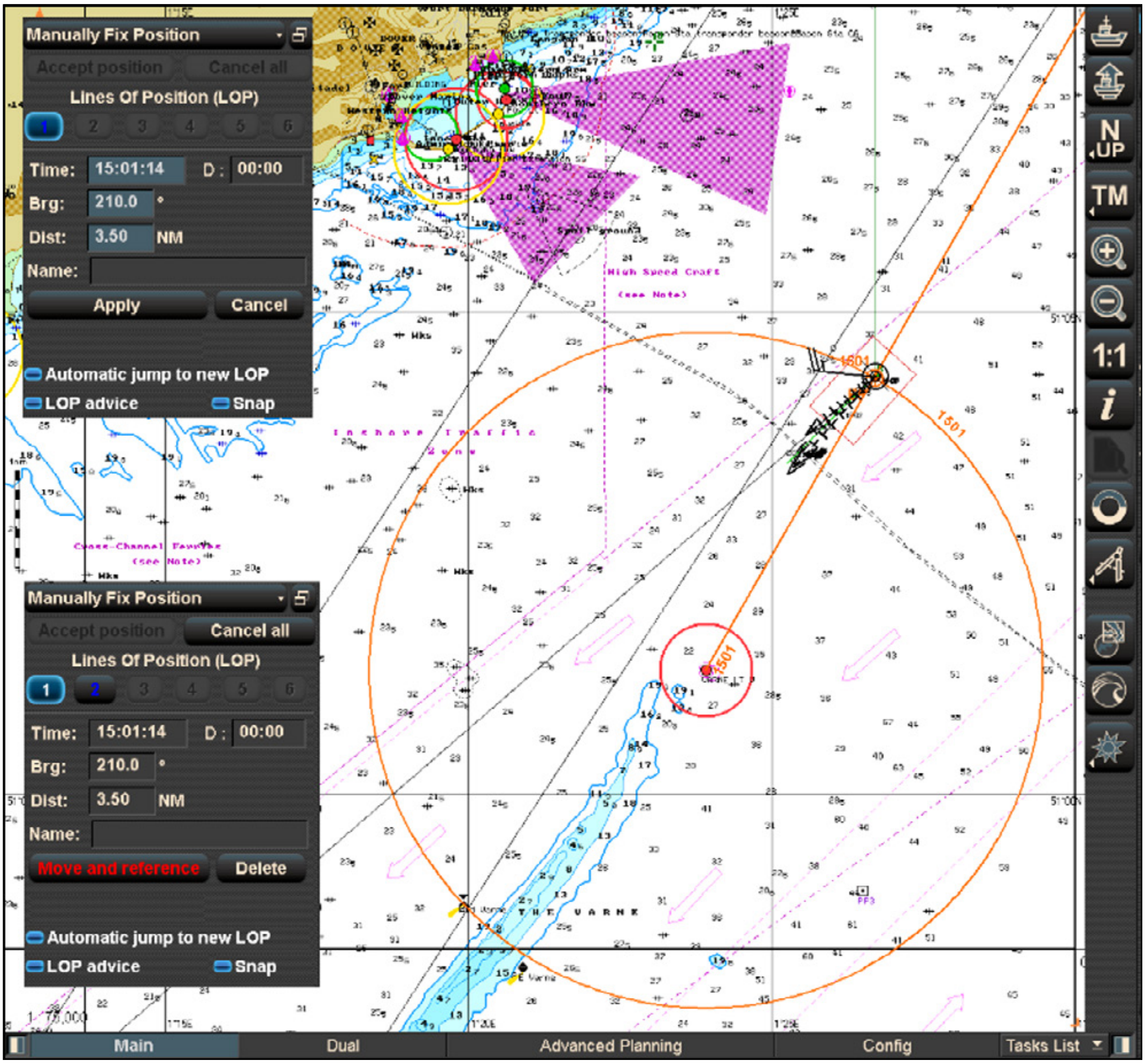


Fig. 4.26. *Manual position fixing using bearing and distance (TRANSAS NTPro 5000).*

The sequence of manual position fixing on ECDIS is as follows (see Fig. 4.26):

- measure bearings and / or distances;
- correct bearings with compass error;
- on ECDIS – Control panel → Display panel window → Manually Fix Position, select type of LOP – Bearing, Distance or BRG / Dist;
- input source data for 1–6 LOP and apply entries;
- reference LOPs to the appropriate objects using *Move and reference*;
- obtain the ship's position and assess the reliability;
- move the secondary position to the fixed position if the position is reliable;
- accept the position and make the entry in the ECDIS electronic logbook.

LOP advice – a function providing the warning that the position line is more than 1 mile away from the reckoned position (number turns red).

Snap – LOP automatic referencing to objects, if it is not farther than 0.5 mile from its position.

4.2. ECDIS ALARM AND WARNING MANAGEMENT

This chapter describes the alarm and warning generation causes, their explanation and actions to avoid them.

4.2.1. Alarms and indications

Alarm presentation features are as follows:

- audio and visual signal announcing a condition requiring immediate attention or operator's action;
- signal displayed in „Alarms" window;
- signal associated with intermittent sound signal, which lasts until the silencing;
- the name of the alarm source is shown the red colour.

Warning presentation features are as follows:

- it announces a condition requiring non-immediate attention for precautionary reasons;
- it is shown in „Warnings" window;
- it is accompanied with sound signal, whose duration is 2 sec.;
- the name of the warning source is shown in orange.

Indicator: Visual indication giving information about the condition of a system or equipment.

4.2.2. Sensor alarms and warnings

Sensor alarms and warnings are about the presence of incorrect data from external sensors, or about absence of this data, which are selected as sources of the data. These alarms are not generated unless the related sensors have been selected by the user for the information sources.

Sensor alarms

Datum unknown – no DTM message is received from EPFS. Check DTM output message from primary D-GPS.

Echo reference loss – loss of the radar target, which served as a reference point in the ship positioning by the acquired ARPA objects. Re-set the ER positioning method or set any other positioning method.

Prim. not WGS 84 – coordinates received from primary position source do not match the coordinates on WGS-84. Use another EPFS sensor.

Prim. posn invalid – the data received from the primary positioning source is invalid. Check the primary EPFS operation. Use alternative source of position, call service engineer.

Prim. posn: no data – no data is received from the primary positioning source. Check the primary EPFS operation, use alternative source of position, call service engineer.

Prim. sensor: no input – primary positioning source has no connection or device is switched off. Check the EPFS operation and connection.

Sec. posn invalid – the data received from the secondary positioning source is invalid. Check secondary EPFS operation, call service engineer.

Sec. posn: no data – no data is received from the secondary positioning source. Check the secondary EPFS operation. Call service engineer.

SOUNDER invalid – the data received from the depth source is invalid. Check echo sounder operation, call service engineer.

SOUNDER: no data – no data from the depth source is received. Check echo sounder operation. Call service engineer

SOUNDER: no input – depth source has no connection or device is switched off. Check echo sounder operation and connection.

Sensor warnings

Check Posn-HDG-STW – at the ECDIS start DR positioning mode is set. Check the ship's position and motion parameters.

Prim. diff. mode lost – primary position source loss of differential positioning mode for a time interval longer than the set one. Check the ship's position.

Reference point changed – change of reference point due to loss of heading. Check connection of gyro.

Sec. diff. mode lost – secondary positioning source loss of differential positioning mode for a time interval longer than the set one. Check the ship's position.

Sounder depth – depth under keel is less than minimum sounder depth. Pay attention to the sounder readings.

4.3. CHART ALARMS AND WARNINGS

Chart alarms

Course difference – difference between current route leg and heading is larger than set. Check the monitored route.

Danger area – the ship is going to cross the area marked as danger. Pay attention to the danger line.

Danger line – the ship is going to cross the line marked as danger. Pay attention to the danger line.

End of TCS track – 5 min remaining to the last WP on TCS track. Pay attention to the route under monitoring, switch AP to "Heading mode" or "Manual mode".

Land danger – the ship is approaching the object with "Land" status. Pay attention to the AIDS to object with the "Land" status on ECDIS task.

Nav. danger – the ship is approaching an isolated danger. Pay attention to the isolated danger on ECDIS task.

Off chart – the ship has sailed beyond the chart boundary with the chart autoload mode OFF. Load the chart under the ship's position on ECDIS task.

Out of XTD – the set XTD value is exceeded. Check if the course set in the autopilot is correct.

WPT approach – the ship has approached a WPT. Acknowledge the alarm by pressing ALARM button on the Control panel.

Prim/Sec diverged – difference between the readings of primary and secondary positioning systems is exceeding the set value. Check the EPFS operation.

Safety contour – the ship is crossing safety contour set by the operator. Check the ship's position and motion parameters.

Traffic SS crossing – the ship is going to cross the "Traffic separation scheme crossing" area. Pay attention to the "Traffic separation scheme crossing".

WPT approach – the ship has approached a WPT. Acknowledge the alarm by pressing ALARM button on the Control panel.

Chart warnings

Ag. monitoring off. – monitoring of navigational dangers is not performed, there is no vector chart under the ship's position. Load vector chart under the ship's position.

Ahead the schedule – the ship is ahead of the schedule. Check the ship's position and motion parameters.

AIDS to Navigation – the ship is approaching the Aids to navigation object. Pay attention to the AIDS to navigation object on ECDIS task.

Anchor prohibited – the ship is going to cross "Anchor prohibited" area. Pay attention to the sailing area.

Areas to be avoided – the ship is going to cross "Areas to be avoided". Pay attention to the sailing area.

Behind the schedule – the ship is behind the schedule loaded for monitoring. Check the ship's position and motion parameters.

Cable area – the ship is going to cross "Cable area". Pay attention to the cable area.

Cargo transship – the ship is going to cross "Cargo transship. Pay attention to the "Cargo transship area".

Caution area – the ship is going to cross "Caution area". Pay attention to the "Caution area".

Chart datum unknown – system of coordinates of the chart under the ship's position is not identified. Load another chart.

Danger line – the ship is going to cross the line marked as danger. Pay attention to the danger line.

Dangerous scale – the scale of the chart is 5 fixed points larger than the paper original. Set the original scale of this chart (press button 1:1).

Deepwater route – the ship is going to cross "Deep water route". Pay attention to the "Deep water route".

Dredged area – the ship is going to cross "Dredged area". Pay attention to the "Dredged area".

Dumping ground – the ship is going to cross "Dumping ground area". Pay attention to the "Dumping ground" area.

ENC data available – official ENC chart is available under the ship's position. Load ENC chart.

End of route – end of route is loaded for monitoring. Pay attention to the route under monitoring.

Env. Sens. Area – the ship is going to cross "Environmentally Sensitive Sea" area. Pay attention to the "Environmentally Sensitive Sea" area.

Exl. econ. zone – the ship is going to cross "Exclusively Economic Zone" area. Pay attention to the "Exclusively Economic Zone" area.

Explosive dumping – the ship is going to cross "Explosive dumping". Pay attention to the "Explosive dumping".

Fairway – the ship is going to cross "Fairway area". Pay attention to the "Fairway area".

Fishery zone – the ship is going to cross "Fishery zone". Pay attention to the "Fishery zone".

Fishing ground – the ship is going to cross "Fishing ground". Pay attention to the "Fishing ground".

Fishing prohibited – the ship is going to cross "Fishing prohibited" area. Pay attention to the "Fishing prohibited" area.

Harbour limit – the ship is going to cross "Harbour limit" area. Pay attention to the "Harbour limit" area.

HCRF chart rescaled – the scale of ARCS chart is different from original scale. Press button "1:1" on ECDIS toolbar.

HCRF mode – ARCS (ARCS raster charts) mode has been chosen as prioritized one.

Ice area – the ship is going to cross "Ice area". Pay attention to the "Ice area".

Inshore traffic zone – the ship is going to cross "Inshore traffic zone". Pay attention to the "Inshore traffic zone".

Layers lost – not all standard display information layers are shown. Change the scale of the chart.

Look up` better chart – larger scale chart is available for the vessel's position. Choose the larger scale chart.

Marine Farm Culture – the ship is going to approach marine farm culture. Pay attention to marine farm culture.

Military area – the ship is going to cross "Military area". Pay attention to the "Military area".

Nature reserve – the ship is going to cross "Nature reserve" area. Pay attention to the "Nature reserve" area.

NAVTEX polygon – the ship is going to cross "NAVTEX polygon" area. Pay attention to the "NAVTEX polygon" area.

No official chart – display of an electronic chart does not comply with S57 format. Refer to proper paper chart. Change to the official chart under the ship if any on ECDIS task.

Non navigational chart – Transas format chart, which could not be used for navigation. Change to the official chart under the ship's position.

Not recom. scale – the scale of the chart is up to 5 fixed points larger than the paper original. Set the original scale of this chart (press button 1:1).

Offshore prod. area – the ship is going to cross "Offshore production area". Pay attention to the "Offshore production area".

Part. Sens. Area – the ship is going to cross "Particularly Sensitive Sea" area. Pay attention to the "Particularly Sensitive Sea" area.

Pipeline area – the ship is going to cross "Pipeline area". Pay attention to the "Pipeline area".

Precautionary area – the ship is going to cross "Precautionary area". Pay attention to the "Precautionary area".

Prohibited area – the ship is going to cross "Prohibited area". Pay attention to the "Prohibited area".

Quarant. anchorage – the ship is going to cross "Quarantine anchorage" area. Pay attention to the "Quarantine anchorage" area.

Recomm. traffic lane – the ship is going to cross "Recommended traffic lane". Pay attention to the "Recommended traffic lane".

Restricted area – the ship is going to cross "Restricted area". Pay attention to the "Restricted area".

Safety contour changed – with a change of chart set under the ship's position, the previously selected safety contour becomes unavailable on these charts. Set a new safety contour value.

Safe scale changed – change of safety scale under the ship for monitoring of navigational dangers. Pay attention to the safety scale.

Seaplane landing – the ship is going to cross “Seaplane landing” area. Pay attention to the “Seaplane landing” area.

SENC larger scale – there is an official chart of larger scale under the ship than the used one. Select the chart of larger scale.

Specially protect. – the ship is going to cross “Specially protected” area. Pay attention to the “Specially protected” area.

Spoil ground – the ship is going to cross “Spoil ground” area. Pay attention to the “Spoil ground” area.

Submarine transit – the ship is going to cross “Submarine transit” area. Pay attention to the “Submarine transit” area.

Swept area – the ship is going to cross “Swept area”. Pay attention to the “Swept area”.

Territor. sea base. – the ship is going to cross “Territorial sea base” area. Pay attention to the “Territorial sea base” area.

Territorial sea – the ship is going to cross “Territorial sea” area. Pay attention to the “Territorial sea” area.

Traffic SS crossing – the ship is going to cross “Traffic separation scheme crossing” area. Pay attention to the “Traffic separation scheme crossing” area.

Traffic SS roundabout – the ship is going to cross “Traffic separation scheme roundabout” area. Pay attention to the “Traffic separation scheme roundabout” area.

Traff. separ. zone – the ship is going to cross “Traffic separation zone” area. Pay attention to the “Traffic separation zone” area.

Two-way traff. route – the ship is going to cross “Two-way traffic route” area. Pay attention to the “Two-way traffic route” area.

Unsurveyed area – the ship is going to cross “Unsurveyed area”. Pay attention to the “Unsurveyed area”.

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