UNIT-1 Overview of Navigation and Seamanship

Chapter 1: INTRODUCTION TO NAVIGATION AND SEAMANSHIP AND TYPES OF NAVIGATION

Introduction

Navigation is the process of directing or conducting the movement of a vehicle/vessel from one place to another, safely. The vehicle/vessel can be a surface craft or ship, a submarine, an aircraft, or a space craft. The word navigation derived from two Latin words "***navis***" means a skip, "***agere***" means to direct.

Navigation is a mixture of an art and a science. It is considered as science because involves the development and use of instruments, methods, almanacs and tables. A navigator gathers information from every available source, evaluates this information, determines a fix, and compares that fix with his pre-determined position.

A navigator constantly evaluates the ship's position, anticipates dangerous situations well before they arise, and always keeps "ahead of the vessel. It is considered as an Art because it involves the proficient (well skilled) use of the tools and in the application and interpretation of information gained from such use.

Navigation methods and techniques vary with the type of vessel, the conditions, and the navigator's experience. Navigating a pleasure craft, for example, differs from navigating a container ship. Both differ from navigating a naval vessel. The navigator uses the methods and techniques best suited to the vessel and conditions at hand. Some important elements of successful navigation cannot be acquired from any book or instructor. The science of navigation can be taught, but the art of navigation must be developed from experience.

Types of Navigation

Navigation can be divided into five basic types. They are,

1. Piloting (coastal navigation)
2. Dead reckoning (DR)
3. Celestial navigation and
4. Radio navigation
5. Electronic & satellite navigation

Piloting (Coastal Navigation)

Piloting involves navigating in restricted waters with frequent determination of position relative to geographic and hydrographic features. Piloting may be defined as the determination of the position and the direction of the movements of a vessel involving frequent or continuous reference to landmarks, aids to navigation and depth soundings. Land marks such as natural land features, structures and other objects ashore which although not constructed for that purpose, can guide the mariner. Piloting is done only in coastal water where we have a sight on land. Piloting normally provides a vessel's position with precision and accuracy. The term aids to navigation mean any object or device, external to a vessel that is used to assist a navigator in fixing his position or determining a safe course. Lighthouses, light buoys, beacons, towers, churches, mountains are few examples for aids to navigation.

Dead Reckoning (DR)

Dead Reckoning (DR) is the fixing of a present position or anticipated (expected) future position, from a previous position using known directions and distances. In dead reckoning, projections are made from planned course and speeds without allowance for wind and current. Courses are determined by the compass, (magnetic or gyrocompass) and speed is taken from a log or count of engine revolutions. The plot of DR positions can be done either manually or by dead reckoning tracer which automatically analyses directions and distances and plot a continuous track. The DR position is only an approximation, because the wind, current, waves and steering errors are not taken to account. If there is no wind, current, waves and steering error then DR provides an accurate indication of position.

Celestial Navigation

Celestial navigation is the determination of position by observing the celestial bodies such as the Sun, Moon, planets and stars, by drawing lines Of position using tables, spherical trigonometry and almanacs. It is used primarily as a backup to satellite and other electronic systems in the open ocean. Navigators recognizing the deficiencies of dead reckoning when carried on for days without knowing the effects of wind and current, soon developed techniques by observing heavenly bodies. Although presently electronic devices are widely used, the celestial navigation remains a basic and widely used procedure for determining positions at sea. Less accurate method than piloting but safe enough for a vessel at sea.

Radio Navigation

Radio navigation is the determination of position and to lesser extent, course direction using information gained from radio waves received and processed on board a vessel or aircraft. It uses radio waves to determine position by radio direction finding systems. Radio navigation system in general provides coverage of a few hundred to many thousands of miles with accuracies from ± 5 miles. Celestial navigation requires is simple and self-contained but requires fair weather in order to observe heavens and horizons. Radio systems are generally usable regardless of the weather but are subject to power and equipment failures.

Electronic and Satellite Navigation

Electronic navigation is the finding of position by using information gained from electronic equipments onboard a vessel. The term "electronic navigation", sometimes used more properly includes all electronic devices such as radar, radio beacon, becca, Loran-c, Omega and satellites are employed in this navigation.

Satellite navigation uses artificial earth satellites for determination of position

Position, Direction & Distance

Position:

The most basic problem is that of locating the position of the vessel at sea. Mariner cannot direct the movements of his vessel with accuracy, safety and efficiency without fixing his position frequently.

The term position refers to any identifiable location on the earth or a point within a man-made system of artificial coordinates.

Direction:

Direction is the knowledge of the spatial relationship between two positions. The direction from one to another that makes it possible for a navigator to lay a course from where he is to where he wants to go, and then proceed to that destination.

Direction is the orientation of an imaginary line joining one point to another without regard to the distance between them. Direction is measured in angular units, degree of arc from a reference using a polar coordinate system.

The usual reference direction is True North or Geographic North. The subdivision of a degree may be either minutes and seconds (1° = 60' ; 1 ' = 60"), or decimal fractions.

Distance:

Distance is the spatial separation between two points without regard to direction. In navigation, it is measured by the length of a line on the surface of the earth from one point to the other; customary units are yards, miles or kilometers.

The "mile" commonly used by navigators is the International Nautical Mile, which is equal to **6076.1 feet**. This is longer than the **Statute Mile** (**5280 feet**) used on land.

1 Nautical Mile = 6076.1 feet

1 Nautical Mile = 1.852 km = 1852 m

1 fathom = 1.829 m = 6 feet (l foot = 0.3048 m))

Speed is defined as the time rate of movement and in navigation is usually measured in Nautical Mile per Hour or **"Knots"**. (Note: "Knots per hour" is a wrong usage).

Time is as four digits in a 24 hour system. The time 04:32 A.M. would be written as 0432; and 8:15 P.M would be written as 2015. (The word "hours" is not written or spoken after the four digits.)

Seamanship

Seamanship is an art of handling a ship under all condition of weather, tide or other influences affecting its movement or safety of a ship. The variety of skills needed to enable the safe and efficient operation of any boat, even under stressful weather conditions are called seamanship.

The degree of knowledge needed within these areas is dependent upon the nature of the work and the type of vessel employed by a mariner. However, the practice of good seamanship should be the goal of all. A fundamental skill of professional seamanship is being able to operate a vessel with accuracy and precision.

Ship-handling

A fundamental skill of professional seamanship is being able to operate a vessel with accuracy and precision. Unlike vehicles on land, a ship afloat is subject to the movements of the air around it and the water in which it sits.

Seamanship is the name for excellence in boat handling and its scope is so wide that even the most experienced sailor cannot hope to learn everything about it in one lifetime.

Seamanship - General word for the arts and skills associated with handling a boat, especially with handling her efficiently and well.

Good seamanship includes thorough knowledge and intelligent application, of all the principles of operating a boat away from her pier or mooring - getting underway, safety practices, piloting, manoeuvring (operating) in difficult situations, avoidance of hazards and so on - plus the constant exercise of prudence, good judgment and consideration toward others.

Perfection in all these things is a goal every thoughtful skipper strives for.

Chapter 2: EARTH AND ITS COORDINATES

Introduction

The Earth is an <u>oblate spheroid</u> shape (a sphere flattened at the poles). The position of aids must be known for safe direction of vessels, so it is must to know something about earth; earth's surface and its co-ordinate and units of measurement used. The system that has been developed over many centuries is called latitude and longitude. The location and measurement of latitude and longitude essentially involves complex mathematics (especially geometry) and a series of international agreements/ conventions for recording locations on the surface of the Earth.

The earth can be described more exactly as a "spheroid," which simply means a less than perfect sphere. The equatorial diameter of the earth is quite 6,888 nautical miles (12,757 km); the <u>polar diameter</u> is nearly 6,865 nautical miles (12,714 km), or about 23 miles (**43 km**) **less**.

The axis on which the earth rotates is called the geographic Polar Axis. The two points where the axis meets the surface of the sphere are called:

The North Geographic Pole - or True North; and

The South Geographic Pole - or True South

Great Circles

A great circle is a circle formed on the surface of the earth by the intersection of a plane passing through the center of the earth, thereby dividing the earth into two equal parts.

Equator (Great circle):

Half way between the two poles a plane perpendicular to the axis intersects the surface of the earth in a line known as the equator.

Great circle is a circle on a sphere whose plane passes through the centre of the sphere. If one cuts a sphere along a great circle the plane will pass through the centre and divide the sphere into two equal halves.

The plane of the equator divides the earth in half into the northern and southern hemispheres.

Small Circle

A small circle is a circle format on the surface of the earth by the *intersection of a plane which does not pass through the centre of the earth* and does not divide the earth into two equal parts.

Although "small circles" may actually be quite large, they are always smaller than any great circle of the earth.

Poles of the Earth

Poles of the earth are the two points *90° away from any point on the equator* and are the points through which the axis of the earth is assumed to pass. All meridians on the earth pass through both the poles. The poles of the earth are the points where the earth's axis meet the surface.

Parallels and Meridians

A parallel is a small circle on the earth's surface whose plane of inter section is parallel to the plane of the equator.

The equator itself is a special parallel in that it is a great circle.

- All ***Lines of' Longitude*** run through both Poles and each is half of a Great Circle
- For Lines of Latitude only the Equator is a Great Circle

Latitude

Latitude (L, lat.) is the angular distance from the equator, measured north-ward or south-ward along a meridian from 0° at the equator to 90° at the poles. It is designated north (N) or south (S) to indicate the direction of measurement

The latitude of a point may be considered either as the angular distance measured from the centre of the earth or as an arc on the surface. Latitude is normally measured in degrees, minutes and seconds, or in degrees, minutes and decimal fractions of a minute; the suffix "north" or "south" is an essential part of the description and must always be included.

Longitude

Longitude (l, long.) is the angular distance between the prime meridian and the meridian of a point on the earth, measured eastward or westward from the prime meridian through 180°. It is designated east (E) or west (W) to indicate the direction of measurement.

The prime meridian, longitude 000°, is universally taken as the meridian which passes through the original site of the Royal Observatory, Greenwich, England. All modern charts use the prime meridian as the starting point for the measurement of longitude.

Degree Length

The length a degree of latitude (measured along a meridian) is everywhere the same on a sphere, from the equator to the poles. On the earth, for practical navigational purposes, it is equal to 60 nautical miles (111.12 km), and 1 minute of latitude is equal to 1 nautical mile (l.852 km).

The length of a degree of longitude (measured along a parallel) decreases from 60 nautical miles (111.12 km) at the equator to **52.1** nautical miles (96.48 km) at latitude **30°** north to south, and to **30.13** nautical miles (55.8 km) at latitude **60°**; it is **zero** at latitude **90°** the north and south poles.

Distance in Navigation

Abbreviated as Dist., symbol D. It is defined as the shortest distance between any two points on the surface of the earth is always along the great circle between them. Speed (S) is rate of motion, or distance per unit of time. A knot (kn.), the unit of speed commonly used in navigation, is a rate of 1 nautical mile per hour.

In 1929, the international community agreed on the definition of 1 international nautical mile as 1852 meters, which is roughly the average length of one minute of latitude i.e. one minute of arc along a line of longitude (a meridian).

Or to put it shortly: 1 nm = 1' **(or)** 1° of latitude = 60 nm.

Directions in Navigation

Direction is the position of one point relative to another, Navigators express direction as the angular difference in degrees from a reference direction, usually north or the ship's head. Course (C, Cn) is the horizontal direction in which a vessel is steered or intended to be steered, expressed as angular distance from north **clockwise** through 360°.

The course is often designated as true, magnetic, compass or grid according to the reference direction.

In navigation, true direction is the direction from one point on the earth's surface to another, without regard for the distance between them; it is expressed as an angle in degrees from 000 to 360, referenced to true north. Direction is always expressed in three digits; for example, a direction 8 east of north is expressed as 008, and one 34 east of north as 034. True north may be considered as either 000 or 360.

True Direction

If direction is expressed in reference to the geographic pole, then it is said to be True Direction, and is symbolized by True North is therefore written as 000° T (360° T) or 000T (360T).

Magnetic Direction

The surface of the Earth is covered by a weak magnetic field. The entry and exit points of the field through the earth's surface (which is where the field lines are perpendicular to the surface) are called the Magnetic Poles. Because of their proximity to the North and South Geographic Poles, the magnetic poles are referred to as the North Magnetic Pole and the South Magnetic Pole.

It is a useful property of a magnetic compass that it aligns to the magnetic field lines and therefore points in the direction of Magnetic North.

Unfortunately for navigation, the magnetic poles and the geographic poles are not in the same location and consequently there is a small but significant difference between the True (i.e. geographic) Direction as shown in the chart and the Magnetic Direction as indicated by the compass.

Rhumb lines

A line which crosses every meridian of the sphere at the same angle is rhumb line (also known as **Loxodromes** or **Loxodromic Spirals**).

Chapter 3: NAUTICAL CHARTS

Introduction

The nautical chart is one of the mariners' oldest and most widely used navigational aids. *A Nautical chart or Navigational Chart is a graphic (pictorial) representation of a navigable portion of the earth's surface, on a plane surface*. It has been specially designed for the use of navigation.

It is used to work upon, not merely to be looked at, and should readily permit the graphic solution of navigational problems such as distance, direction and determination of position in terms of latitude and longitude. It shows information such as coastline, harbour, depth of water, nature of bottom, channels, land marks, dangers and other information of interest to navigatior.

When the ship is being navigated along or near the coast, the art of fixing the ship's position graphically, *laying a safe course to destination and checking ship's position whilst on, the course to ensure the vessel's safe arrival is called* '**Chart work**'

As the safety of the ship depends upon the accuracy of the navigational chart, utmost care is taken in its construction. It is drawn precisely giving full details of all the information required by the navigator.

Maps: A map is representation, in miniature, on a flat surface, of a portion of the earth's surface. It shows physical features; cities, towns, and roads; political boundaries; and other geographic information.

Charts: A chart is also a representation of a portion of the earth's surface, but has been specially designed for convenient use in navigation. It is intended to be worked upon, not merely to be looked at, and should readily permit the graphic solution of navigational problems, such as distance and direction for determination of position, in terms of latitude and longitude.

A nautical chart has to do primarily with areas of navigable water. It features such information as coastlines and harbours, depths of water, channels and obstructions, and landmarks and aids to navigation.

Preparation of Charts

Charts are produced by the **Hydrographic Department of the Admiralty, British**, under the hydrographer of the navy who is responsible not only for the preparation, correction, issue of charts and other navigational publication, but also for the surveying works.

In India **Hydrograhaphic Department of Indian Navy** based at **Dheradun** is responsible for printing and publishing of charts.

After the chart is published and distributed, it must be kept ***up-to-date*** by incorporating any changes or corrections, which may have occurred subsequently. Such corrections and changes in charts of various parts of the world are issued as "***Notices to Mariners***" by the Hydrographic Department.

Classification of Nautical Charts

1. World charts:

These charts are **'Very small scale'** covering the large area of the world showing ocean routes, magnetic variations, telegraph cables, ocean currents etc,

2. Ocean charts:

There charts are prepared on a **'Very small scale'**, covering large portions of the earth e.g. Indian Ocean, North Atlantic Ocean.

On such charts only the outstanding coastal features and important ports etc. are shown. Since these charts show little detail these charts are **unsuitable for coastal navigation**. These charts are used for planning and executing **long voyages** *across the oceans.*

The scale of these charts ranges from 1 : 6,00,000 to l : 14,000,000.

3. Coastal charts:

These charts are of **'Medium scale'** and cover only a portion or a part of the coast. They show all the aids to navigation like lighthouses, Radio station, important navigation marks, off lying rocks, dangers etc. These charts are used when the ship is being *navigated along the coast*.

Coast charts thus highlight the features on and along the coast and the adjoining portions of the sea.

The scale of these charts ranges from **1:50,000 to 1:6,00,000** E.g. Mumbai to Cape Comorin

4. Plan charts:

These charts are drawn on a **'Very large scale**' and each plan covers only a small area e.g. Tuticorin harbour.

They contain all the information required when *navigating a ship inside the harbour* and other *congested and enclosed waters*.

Every possible information of use to navigator is shown in great detail. The scale of these plan charts enables the mariner to plot his position with great accuracy and thus avoid the dangers, which are frequent in ports and harbours.

The chart with a scale ranging from **1:2,500 to 1:50,000.**

Important Information of a Nautical Chart

1. Charts Reading:

Charts reading need practice. The *abbreviations and symbols* on the chart must be recognized and understood without mistake. There is only one way to learn to read a chart: look at it for a long time, and orientated it with the area it describes.

2. Title of chart:

The title of each chart is printed in some convenient, conspicuous place on a chart, where it does not hinder the navigational use of it.

The title is in clear and bold print.

Under this title, the information about chart datum, Natural scale, projection, heights, bearings, Tide table, Notes, caution, authorities and dates of survey are available.

3. Tide table:

The height of tides in the tide tables are all above the chart datum and as the ***level of water is always more than that of the chart datum*** the ***error is always on the safer side***. Tidal information is given usually in the form of tables.

4. Natural Scale:

Natural scale is the relationship between the actual length of something on the earth and the length by which that thing is shown on the chart.

It does not matter what size the unit is or in what system it is measured for example, a scale of 1/80,000 or 1:80,000 means that one unit (inch, foot, meter, mile etc.) on a chart represent 80,000 such unit on the earth.

5. Caution: Cautions are given in respect of the use of chart.

6. Projection:

Shows the type of projection such as ***Mercator projection, Gnomonic*** or other projection.

7. Notes:

Much valuable information is printed on charts in the form of notes. Notes will relate to such topics as ***regulatory restrictions, cautions and warnings, unusual magnetic conditions***.

8. Authority:

A statement of the authorities on which a chart is based, is given in the title of each chart. If chart is derived from a number of surveys; the dates and areas of the surveys may be difficult to define concisely in the title: on the latest charts compilation diagrams showing the dates and coverage may be included in such cases.

9. Dates of survey: Dates of surveys on which the chart is based.

10. Number of the Chart:

Each chart has a serial number attached to it. This is printed at the ***bottom right hand*** and the ***top left hand corners*** of the chart. These numbers are essential in identifying the chart.

11. Date of Publication:

The date of publication along with the name of the Hydrographer to the Government authority is printed at the bottom, in the middle just outside the margin. Recent publication would mean a more reliable chart, incorporating all corrections, large and small, up to that date.

12. Date of Printing:

This is shown as the number of the day in the year, printed at the top right hand corner, outside the margin e.g. 335.88. This means that the chart was printed on the 335th day of 1988.

13. Plate Dimension

The figures in brackets shown ***outside the lower right hand border*** of the chart thus (425.0 x 860.0 mm) or (34.46 x 25.49) express the dimension in millimetres or inches of the plates from which charts are printed.

14. Compass rose

The compass roses are printed on the chart, at ***two or three places***, wherever it is possible, so that it does not interfere with any useful information given on the chart. Compass roses for laying bearing and courses.

15. Depth contours

These are lines joining places of equal depth and most charts have depth contours to indicate the shallower areas on the chart.

16. Soundings:

Soundings mean the depths of water below the chart datum and are thus one of the most important features of the navigational chart.

The units used for soundings are clearly shown below the "Title" of the chart.

Soundings are indicated by figures showings in meters and fathoms. The depths are indicated by a normal-sized sounding figure with a smaller figure below and to the right of it.

For example,

Fathoms: 5_2 (5 fathoms 2 feet = 32 feet) (l fathom = 6 feet)

Metres: 5_2 (5.2 metres = 17 feet approx.)

17. Nature of Bottom

This is described on the chart in abbreviated form such as S for sand, Co for coral, M for mud etc. The information is very useful when anchoring a ship and fishing.

Chart seabed abbreviations			
Bottom Type		**Bottom texture**	
S	Sand	**f** or **fne**	fine
M	Mud	**bk** or **brk**	broken
Cl or **Cy**	Clay	**s** or **stk**	stiky
Sh	Shells	**so** or **sft**	soft
Grs	Grass	**h** or **hrd**	hard
K	Kelp		
Rk or **Rky**	Rocky		
Co	Coral		
Co Hd	Coral head		
Bids	Boulders		
Oys	Oyesters		

18. Colour Shading

Modern charts have a system of colour shading to give greater emphasis to certain depths. This is particularly the case with inshore soundings.

Shallow waters are usually indicated by **deep blue** colouring (green if they are dry at low tide), which fades out to **paler blue** as the water becomes deeper. The land is often shaded **yellow**.

Navigation lights, which are the navigator's signposts, as it were, are indicated by a **red 'flash'**.

Hints for using a Chart

1. Always use the <u>largest scale</u> charts available for the area.
2. Note carefully the <u>units</u> in which soundings are given.
3. Familiarise yourself thoroughly with <u>graduations</u> on the chart before reading the Latitude and Longitude.
4. Always <u>keep the chart dry</u>. Keep bottles and pens away from the chart.
5. Use soft black pencils and soft erasers.

Uses of Charts

a. To obtain a course:

The direction in which a vessel is to be steered or the direction of travel through the water.

b. To draw a bearing:

A bearing is the direction of a known object and thus determines the direction of the line of sight to that object.

c. To find a position:

When two bearings (position lines) intersect, the position of the vessel is said to be fixed. So a fix (position) is therefore the point of intersection of the two-position line. The position is indicated in the terms of latitudes and longitudes.

UNIT 2: NAVIGATIONAL AIDS AND BEARING INSTRUMENTS

CHAPTER L: MAGNETIC COMPASS

Introduction

The magnetic compass is the oldest instrument for navigation and has been an essential tool for navigators at sea to find the directions. The compass shows the way to the ships to steer a selected course.

The four main points − North, South, East and West − are called the **cardinal points**. Next are the **inter-cardinal directions**: **NE, SE, SW** and **NW**.

The magnetic compass still retains its importance, despite the invention of the gyrocompass. While the latter is an extremely accurate instrument, it is highly complex, dependent on an electrical power supply, and subject to mechanical damage. The magnetic compass, on the other hand, is entirely self-contained, simple, comparatively rugged, and not easily damaged.

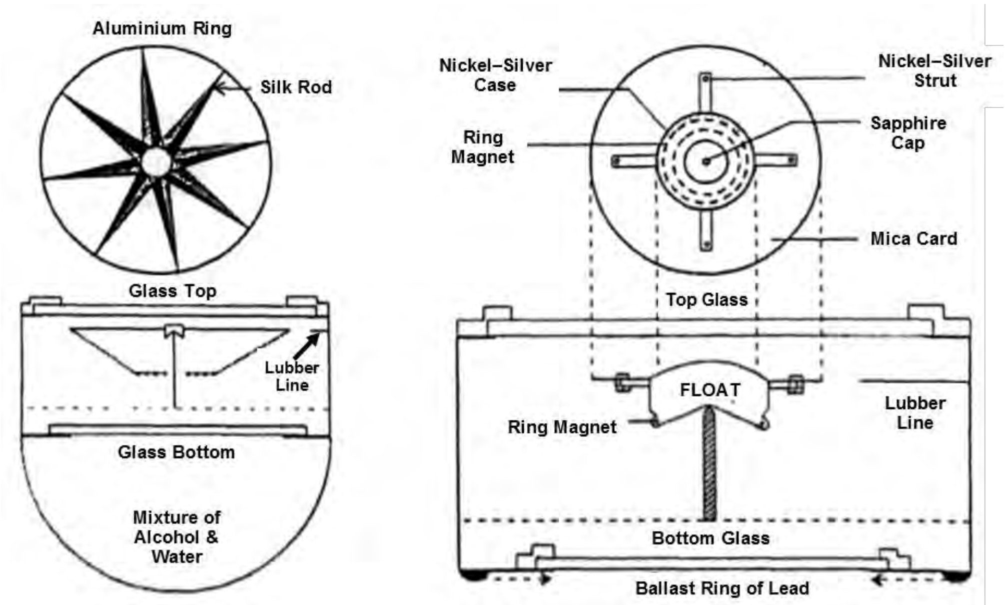
Working principle of magnetic compass

Magnetism is a fundamental physical phenomenon which occurs both naturally and artificially by induction. It is the property of certain metals to attract or repel items of like material or certain other metals. An object which exhibits the property of magnetism is called a magnet. It can be elongated, as in a bar magnet, shaped like a *horse-shoe, or take other forms*. The space around each magnet in which its influence can be detected is called its *field*; this can be pictured as being composed of *many lines of force*. The *lines concentrate at both ends / poles* of a magnet.

Each magnet always has two opposite polarity; one is termed north and the other south. The Earth itself is a big magnet having north and south poles, but the ***poles are not exactly aligned with the rotation axis*** of the Earth. The magnetic compass is working with the principle of ***Earth's Magnetic Field*** and shows the magnetic north and south.

The simplest form of compass consists of a magnetized needle free to rotate in a horizontal plane. Such a needle tends to settle in the magnetic meridian.

Construction of Magnetic Compass



Based on the construction the magnetic compass can be divided in to two types.

1) Dry card

2) Wet card

1. Dry card compass

a. The card base

A lightweight **Aluminium ring** with **254 mm dia.** is attached to a **hub** by a **silk cord** (like cycle wheel with spokes).

Silk cord is used because it does not shrink or stretch due to *moisture* or changes in atmospheric *temperature*.

The compass card is made of **Rice paper** because it is very light and unaffected by changes in temperature.

b. The card support

The bottom of the hub is attached with a **small cap fitted with a sapphire**. This arrangement provides a practically *frictionless support* for the compass card and requires *no lubrication*.

This rests on **a pivot tipped with iridium** which is a hard non-magnetic metal.

c. The directive element (magnets)

The magnets are attached to the card base, which ensures the card is not only north seeking but also remain horizontal even when ship tilts with rolling / pitching.

d. The compass bowl

It is a ***cylindrical* brass bowl** having a transparent **glass top**.

e. The lubber line

There is a small line marked on the inner rim of the compass bowl. This line is called **Lubber line** and it represents the **direction of the ships head**.

If the compass is fitted on the fore and aft center line of the ship the lubber line shows the direction of the *ship's heading*. The reading of the compass card, which coincides with the rubber line, is the *compass course* of the ship.

Suspension of bowl

On the outside of the **compass bowl** there are **2** projections, called **Gimbals** at the same level as the compass card. If the ship rolls or pitches, the **bowl would remain horizontal** because its **center of gravity below gimbals**.

The gimbals are **triangular** in cross-section, **apex downwards**. These gimbals rest on **'V' shaped depressions** in a **horizontal** ring called the **gimbals ring** which encircles the compass bowl.

The gimbals ring itself is pivoted at its forward and after sides.

The top of the **verge ring** is grooved to accommodate the **azimuth mirror**.

f. The Binnacle

The binnacle is a cylindrical container (a protection cover) made of teakwood and brass, Non-magnetic materials are used in its construction. The compass bowl is swing inside the top portion of binnacle.

g. The helmet

Large brass helmet placed on the top of the binnacle is called helmet. This protects the compass bowl from direct sunlight, rain, spray, dew, frost etc.

2. Wet card compass

The dry card compass is sensitive to rolling and pitching and even small movement of vessel because the dry card to oscillate. It is very difficult to take readings. This problem is rectified in the wet card compass and the **oscillations are damped**, without loss of accuracy, by immersing the card in a liquid. The card therefore has a ***dead beat movement***.

a. Card

The wet card is made of **Mica** and has about **15 cm dia.**.

The card is attached to a **Nickel-silver float chamber** that has a sapphire cap.

The cap rests on **Iridium tipped pivot**.

The sapphire has a polishing effect on the iridium tip.

b. Directive element

This is fixed below the card, enclosed in **nickel-silver** to avoid corrosion.

In modern wet card compass the directive element is a **'Ring magnet'** fitted around the base of the float.

The ring magnet offers less resistance to movement and cause less turbulence. The ring magnet wet card is the most efficient type of marine magnetic compass.

c. Liquid

The movement of the card is dampened by filling the bowl with mixture liquid consisting of **distilled water** and part pure **ethyl alcohol** (this is to stop the liquid freezing in extremely cold weather).

The mixture of distilled water and pure alcohol has the following properties,

a. Low freezing about **−30°C**,
b. Small **coefficient of expansion**
c. Does not discolor the card
d. Low relative density about **0.93**,

d. Bowl

Though the wet card is only about 15 cm in diameter, the diameter of the bowl is about **23 cm** in order to reduce disturbances caused by turbulence in the liquid during rotation of the card.

The top of the bowl is of **transparent** glass. The bottom is of **frosted grass** to diffuse the light coming from the bulb below.

Limitations of Magnetic Compass

The following characteristics of the magnetic compass limit its direction-finding ability:

- Sensitive to any magnetic disturbance.
- Useless at the magnetic **poles** (sluggish and unreliable in areas near the poles).
- **Deviation** changes as a *ship's magnetic properties change*.

  The magnetic properties also change with changes in the *ship's structure* or *magnetic cargo*.
- Deviation changes with ***heading***.
- The ship as well as the earth may be considered as a magnet. The effect of the ship's magnetism upon the compass changes with the heading.
- ***Does not point to true north***.

Care and maintenance:

- The doors giving access to the connector magnets should always be kept locked and the key kept in safe custody,
- All magnetic materials such as aerials, stays electrical machinery, wires etc should be kept well away from the compass.
- The **wooden part** of the **binnacle** should be varnished not painted, as paint may cause the doors to jam.
- The **safe iron spheres** and **their brackets** should be painted. This prevents rust.
- The **brass part** of the binnacle should be **polished** regularly.
- The **binnacle light** should be switched off during day time.

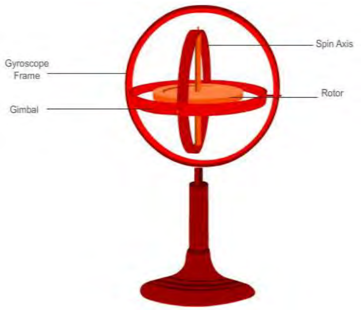
Gyrocompass

Gyrocompass is an **electro-mechanical** device used to find out the direction without adjusting the compass error such as variation or deviation.

The Gyro compass readings are always related to true north.

Gyrocompass will not be influenced by steel structures, electric circuits, etc, this property makes the gyrocompass a very accurate and reliable than magnetic compass.

Gyrocompass is electrically operated and is very accurate and independent of earth magnetism.



Gyroscope

Working principle of Gyro-compass

Gyrocompass is working with the ***high speed*** **gyro-rotor (gyroscope)** to accurately seek the direction of true north.

It operates by seeking an equilibrium direction under the combined effects of the **force of gravity** and the **rotation of earth**.

A Gyroscope is an apparatus in which a **heavy flywheel** or **top** rotates at high speed, the **turning movement resisting change of direction of axis**.

Parts of Gyro-compass

A modern gyrocompass unit consists of a master unit, a control cabinet, a power supply unit, a speed unit and auxiliary electrical transmission and alarm units.

1. **Master compass** consists of a sensitive element of gyroscope. The compass card has illumination facility and its brightness is adjustable.
2. **Control cabinet** for ***computing*** and ***amplifying*** circuitry components.
3. **Transmission Unit** consists of ***amplifiers*** and ***repeater switches***.

   It is used to transmit the heading data of the master compass to the repeater compasses and other equipment such as auto pilot, radar direction finder etc.
4. **Power adapter** is used for converting the ship's power supply into the power necessary for operating the ***static inverter*** and ***transmission units***.
5. **Repeater** indicates the ship's heading shown by master compass *by means of a signal from the transmission unit.*

Advantages

Gyrocompass has the following advantages over the magnetic compass.

1. It seeks the *true north* instead of the magnetic north.
2. It can be *used near the earth's magnetic poles*, where the magnetic compass is useless.
3. It is *not being influenced by surrounding magnetic or electric materials* which might influence the readings of the magnetic compass.
4. Its information can be fed *electronically into **automatic steering unit** or **autopilot***.
5. Corrections like *variation and deviation need not be applied* in the readings of gyrocompass and the readings are very accurate.

Limitations

1. It requires a constant source of **electrical power**. In case of any interruption in its operation for any length of time, nearly **four hours** may be required for it to settle back into reliable operation.
2. It requires intelligent care, attention and **maintenance**
3. The accuracy decrease when **latitudes above 75°**.

Compass error – I

Variation

Since the magnetic poles of the earth do not coincide with the geographic poles, a compass needle (in line with the earth's magnetic field) will not indicate true north. The direction in which it points at any position on the Earth's surface is known as the direction of the magnetic meridian.

*The angular difference between the true meridian and the magnetic meridian is called **Variation** or **Magnetic Variation** or **Declination**.*

Or in other words, Compass needle point to MAGNETIC NORTH, which varies from True North by an error is termed VARIATION. The value of variation should always be suffixed with East or West.

This variation has different values at different locations on the earth. The variation values are place and time specific. The variation values ***could be obtained from compass roses*** of navigational charts.

The name and the value of the Variation at any point on the Earth may be found from the appropriate Magnetic Variation chart. On such a chart a line joining places of equal variation is known as an **ISOGONIC LINE**.

Compass error-II

Deviation

Local magnetic fields in a ship may cause the resultant filed at the compass position to lie in a different direction from the Earth's field alone. A ship is built by the steel and steel alloys, and these materials may influence the magnetic needle of the compass placed nearby.

The magnetism in the hard iron component will be permanent and will remain constant whatever the direction of the ship's head. Boats themselves can also affect compasses due to their construction, steel engines, keel, Ferro-magnetism, electromagnetism, (loudspeakers, mobile phones, hand held VHF) and deck cargo on large ships. This effect is called Deviation, and will vary with the heading of the boat.

*Because of the ships's magnetic effect the compass needle deflected from magnetic north to compass north, the difference between magnetic north and compass north is termed as '**Deviation**'.*

The sum of variation and deviation is called as compass error. The navigator must understand thoroughly how to apply variation, deviation, and compass error, as he is frequently required to use them in converting one kind of direction to another.

Direction can be expressed three ways;

1. **True direction**, when referred to the *true (geographic) meridian* as the reference of measurement.
2. **Magnetic direction**, when referred to the axis of the *magnetic meridian* as the reference of measurement.
3. **Compass direction**, when referred to the axis of the *compass card* as the reference of measurement.

Any given direction may be expressed in all three of these ways, if it is understood that:

- True differs from magnetic by variation.
- Magnetic differs from compass by deviation.
- Compass differs from true by compass error.

Chapter 2: MARINE SEXTANT AND BEARING INSTRUMENTS

Sextant is an optical instrument used for measuring angles between any two points horizontally and vertically.

Today's sextant is an instrument is an instrument designed to permit measurement of the angle between the lines of sight to two objects with great precision. It derives its name from the fact that its arc is approximately **one-sixth** of a circle and it can measure angles upto about **120°** or twice the value of the arc itself.

Sextant can be used to measure the attitudes of celestial bodies or vertical angle of any terrestrial body. In spite of the modern electronic navigational equipment, sextant is still retained in the vessels due to its simplicity and reliability. It is extensively used on all medium and large vessels doing long coastal navigation and astronomical navigation.

Working principle of sextant

When a ray of light suffers reflection by two mirrors in a same plane, the angle between the original incident ray and the final emergent ray is twice the angle between the mirrors.

The optics of sextant are based on the system of **double reflection**, in that the image of the body is *reflected from the upper or **index** mirror to the lower or **horizon** mirror and then into the field of view of sextant telescope*, where it is *brought into co-incidence with the **sea horizon*** which is *seen through the clear portion of the horizon mirror.*

Important parts of a sextant

1) **Main frame** on which the other parts are mounted.
2) **Limb** is the lower part of the frame and carries the arc graduated in degrees.
3) **Index arm**: Used to indicate the readings in degrees on the arc.
4) **Micrometer drum** is used to make find adjustment of the index arm.
5) **Index mirror:** mounted at the upper end of the index arm. It is perpendicular to the plane of the instrument.
6) **Horizon glass:** Also perpendicular to the plane, when the index arm is set to exactly zero degree, the horizon glass is parallel to the index mirror. The horizon glass is parallel to the index mirror.

   The horizon glass is divided into two halves vertically. The part nearest to the frame is silvered and the other half is clear optical glass.
7) **Telescope:** Mounted parallel to the plane.
8) **Index shade glass:** These glasses are used to dim the bright celestial bodies.

Error of sextant

There are two types of errors.

1) Adjustable errors.
2) Non-adjustable errors.

1. Adjustable errors are of **four** types.

i) Error of perpendicularity :

If the index mirror is not perpendicular to the plane of sextant the error is found and it is called error of perpendicularity.

ii) Side error: If the horizon glass is not perpendicular to the plane of the sextant, this error is formed.

iii) Index error: When the index arm is at zero mark, the index mirror and horizon glass should be parallel to each other. If they are not parallel, the error is found and it is called index error.

iv) Collimation error:

When the telescope is screwed in place, its longitudinal axis should be parallel to the plane of the sextant. If not, the error is found called Collimation error.

b. Non-adjustable errors

i. **Centering Error:** The index bar should be fitted at the geometrical centre of the circle of which the arc follows part of the circumference. Otherwise, there will be entering error.

ii. **Shade Error:** If the two sides of the coloured shades are not parallel

iii. **Prismatic Error**: If the surface of the mirror is not exactly eve.

iv. **Graduation error**: If the graduation on the arc is not correctly made

Uses of Sextant

The sextant is used for measuring the angle at the observer's eye between.

- The top of some object such as lighthouse, tower etc. and the waterline (horizon) when the sextant is held vertically.

  This is called **Vertical Sextant Angle (VSA)**.

- Two objects on different bearings on shore with the sextant held horizontally is called **Horizontal Sextant Angle (HAS)**.

Bearing Circle and Azimuth Circle or Azimuth Ring

- An azimuth circle is an instrument for determining both bearings of terrestrial objects and azimuths of celestial body.
- This is a nonmagnetic metal ring. It is an **auxiliary instrument** of the compass.
- It consists of a **prism** mounted on a horizontal axis above and inclined to in which there is a **magnifying lens**.
- **Shades** are provided to enable bearing of bright objects being taken. It is mounted on a compass and is capable of being rotated over it.
- This arrangements permits bearings of celestial and terrestrial objects being taken.
- An azimuth circle without the housing and spare mirror is called a **bearing circle**

Pelorus (Dumb compass)

A clear view in all directions may be unobtainable from the compass. Pelorus or dumb compass are used for this purpose. The pelorus is a portable instrument additional to the compass, but in some boats a pelorus may be fixed in a suitable position giving more or less all round visibility.

It consists of a circular brass plate graduated like a compass card. This plate is capable of being rotated by hand within fixed ring, which carries lubber line.

Outside the fixed ring a set of sight vanes are provided which can also be rotated by hand.

The sight vane is provided with a reflecting mirror and shades for taking bearings of right objects.

This instrument is mounted in such a way that it remains horizontal in spite of the rolling and pitching of the ship.

It is used on board for taking bearings of objects which are not visible from the compass position and for finding deviation and correcting them while swinging the ship for compass adjustment.

To take a bearing with pelorus mount it in a convenient position on the wing of the bridge and align its lubber live parallel to the fore and aft line of the ship.

CHAPTER 1: LEAD LINE AND ECHOSOUNDER

Introduction

Depth measurement could be done by two ways one is mechanical another one is electronic. In the ancient days mechanical device- lead line was used to measure the depth. The lead line is also called as hand lead line, is the oldest and most reliable depth-finding device for shallow waters.

Lead line is for taking soundings (which means measuring the depth of water) up to **20 fathoms** (120 feet). But the deep sea lead line is used to measure depth up to **100 fathoms** or more.

The principle of lead line is very simple. A weight (generally lead) is lowered to the sea bed by a graduated line. The length of rope immersed gives the depth measurement of water.

The common electronic instrument used for measuring the depth is echo sounder; of course this was introduced only after the Second World War.

Construction of lead line

Hand lead line

The hand lead line consists of a tapered bar of lead weighing from 7 to 20 pounds, which is attached to a graduated rope. The long rope is marked with strips of cloth and leather to indicate the various depths, and the rope is wound on small wooden reel.

The cavity available in the bottom of the tapered bar of lead is filled with a hard waxy substance, so that when the lead touches the sea-bed, some of the soil gets stick in the waxy material in the cavity, This will be useful to identify the nature of the sea-bottom.

The cable-laid hemp rope or nylon rope is used with the length of **25 fathoms** (150 feet) and **10 mm** in diameter. One end of the rope is attached with lead weight by means of eye splice. Before marking a new lead line, it should be stretched, and thereafter mark the line before it get dried. Mark the line every fathom, (1.83 metres) with any marking colour and number them 0, l, 2, 3, 4 etc.

Now place the end of the eye splice on the first marking (zero) and mark the lead-line at 2, 3, 5, 7, 10, 13, 15, 17, and 20. Fathoms which correspond with the depths marked are called marks.

There are no markings at l, 4, 6, 8, 9, 11, 12, 14, 16, 18 and 19 fathoms. These are called "**Deeps**".

There are altogether **9 Marks** and **11 Deeps**.

Different types of materials are used for marking, such as leather, linen, bunting, serge and cord so that a navigator can identify the markings even if there is no light, by touch and feel the material with hand or lips.

Deep sea lead line

The deep sea lead line is constructed as in the case of hand lead line. The lead attached with deep sea lead line is weighing from 30 to 50 pounds and the line being 100 fathoms or more in length. After the introduction of the echo sounder the use of deep sea lead line is almost nil.

Marking on deep sea lead line

Depth	**Markings**
2 fathoms (3-66 m)	2 strips of leather
3 fathoms (5.49 m)	3 strips of leather
5 fathoms (9.14 m)	white rag (white bunting)
7 fathoms (12.80m)	red rag (red bunting)
10 fathoms (18.29m)	Leather strip with a hole
13 fathoms	Blue serge/ same as 3 fathoms
15 fathoms	White calico/same as 5 fathoms
17 fathoms (31.09)	Red bunting /same as 7 fathoms
20 fathoms (36.58)	A rope cord with 2 knots
25 fathoms (45.72)	A rope cord with 1 knots
30 fathoms (54.86)	A rope cord with 3 knots
35 fathoms (64.01)	A rope cord with 1 knots
40 fathoms (73.15)	A rope cord with 4 knots

Operation of Lead line

- The leadsman takes his place at the bow of a boat.
- Secure himself with "breast band" (a wide strip of canvas used like a seat belt) to avoid from falling overboard.
- The leadsman lean forward and swing his lead. Coil the spare line in your other hand, free for running.
- Then swing the lead in a complete circle and throw it as far forward as possible. As the ship moves ahead, heave in the spare line rapidly. (This will facilitate the lead to resting on the bottom and the line tight, when the vessel is directly over the lead.)
- The leadsman can feel that line has reached the bottom by the sudden slack felt in the line.
- Pick up the slack quickly and as the ship moves ahead, the lead will come directly under you.
- See how much of the line is immersed and call out the sounding.
- Recoil quickly in your left hand in anticlockwise direction.
- Wax filled hollow at base of the lead will bring particles of bottom materials (mud, sand, or shingle) to know about the nature of the bottom of the sea.

Introduction to Echo-Sounder

The echosounder was used for measuring the depth of water and to find the fish beneath the vessel. When the echosounder used in fishing vessels then it is called as **fish finder** (also called a **depth finder / sounder / Depth recorder**). In fisheries the term echo sounding (vertical sounding) is usually restricted to sound transmitted from a vessel and returned to it along a line straight down to the sea bed (or bottom). The equipment employing this technique is called an ECHOSOUNDER.

Basic Principles of ecosounder

Sound waves are directed in the same way as light waves in a searchlight, towards the bottom of the sea floor. A pulse of sound sent from the ship is get reflected as echo after hitting the sea bottom. The time interval between transmission of sound wave and the reception of bounced echo is being proportional to the depth of the water. Water depth is determined from the travel time and the speed of sound in water. Water depth can be estimated simply by using an average sound speed and the following relationship: $\mathbf{D = \frac{v_s \times t}{2}}$

Distance between vessel and sea bottom = speed of the sound wave in water multiplied by travel time of sound wave send from vessel and reception of echo by vessel divided by two.

The value is divided by 2 as the sound wave travels two ways from vessel to sea bed and seabed to vessel.

Sound in Water

Sound waves can travel through a material medium such as a gas, a liquid or a solid, with particular speed, but not a vacuum. The frequency thus gives the number of waves or periods per second. A period is also called a cycle and frequency is sometimes expressed as cycles per second (c/s). One thousand cycles per second is one kilocycle per second (1 kc/s).

The unit 'cycle per second' is now internationally called Hertz (1 kc/s 1 kHz) after a famous physicist of the late 19th century. The human ear can detect sounds of frequencies from about 20 Hz to 20 kHz (20 Hz to 20,000 Hz). Those above the normal range of the human ear are termed ultrasonic or supersonic frequencies.

Sound velocity is the distance the sound waves travel per second, which thus corresponds to the frequency multiplied by the wavelength. The sound velocity depends on certain physical properties of the material through which the sound travels namely elasticity and density. In air, the sound velocity is approximately 322 m per second (m/s) at 0°C, and it increases slightly with higher temperature.

In water, sound velocity is about 1,500 m/s at 15°C [roughly 1.5 km/sec (just under 1 mile/sec) or about 4 times faster that sound travel through air] and here also the velocity increases at higher temperatures as well as with increasing salinity. The wavelength of the sound waves can be calculated in a very simple way when we know the sound velocity of the medium and the frequency of the sound.

Sound is partly reflected when it passes from one medium to another having different density and elasticity. The amount of reflection depends on the difference between then properties of the materials. Air and water are materials of greatly different density and elasticity and their interface or the layer at which they meet is almost a complete barrier to sound.

Air bubbles / rocks give strong echoes. Soft, muddy bottoms give weaker echoes. Fish with a swim bladder / air bladder give better echoes than fish without, because the difference in density between the water and the gas in the swim bladder is greater than that between water and fish flesh. Regular changes in depth, salinity and temperature affect the propagation of sound.

Echo-sounders transmit a pulse of acoustic energy down towards the seabed and measure the total time taken for it to travel through the water, i.e. the outwards and return journey. If the measured time is **one second** and it is known that the speed of acoustic waves is 1500 m/s, the depth is obviously (1500 x 1)/2 metres = 750 m.

The echo sounder was originally designed to measure depth of water and then used to find the fishes beneath the vessel. By using the same principle as the echosounder, equipments such as **SONAR** and **net sonde** were developed.

Basic Components of Echosounder

An echosounder consists of 4 basic components.

1. The Transmitter
2. The Transducer
3. The Receiver
4. The Recorder

Block Diagram of Ecosounder

Transmitter

First component of echosounder is transmitter. The function of the transmitter is to produce energy in the form of pulses of electrical oscillations. The pulses of electrical energy are generated at a specified frequency.

In echosounder, the sound wave is not sent out continuously but in short bursts (**pulses**) with longer quiet periods in between.

The duration of the short burst is called the pulse length. The duration of the sound pulse is one thousandth of a second (i.e. one millisecond).

- Pulses of electrical energy will be generated by oscillator of the transmitter.
- **Pulse gate** will determine the duration of the pulse.
- Pulses will be amplified several thousand times by **power amplifier**.

The power of the pulse produced by the transmitter is an important feature of any echosounder and it may vary from a few watts (w) up to several kilowatts (kw).

Transducer

Transducer is very important part of the echosounder, which is fixed in the hull region, below the waterline of the vessel. The main function of the transducer is to convert electrical energy into sound energy when sound is to be sent and conversely, to convert the sound energy into electrical energy when echoes are received.

The transducer is also responsible for concentrating the sound pulse in a directional beam, similar to the beam of light produced by search light.

The width of the sound beam is inversely proportional to the frequency of the sound.

The transmitted pulse of sound propagates through the water away from transducer. The sound pulse travelling through water may face various targets such as fish, seaweed, sea bed etc. These targets reflect or scatter the sound pulse, and some energy returns towards the transducer. This bounced sound (the echo) is detected by the transducer and converted to electrical energy as the received signal. The time at which the echo is received is calculated by the echosounder and the distance of the target from the transducer is calculated.

There are two main types of transducers for sounding equipment used in fisheries

	Transducers type	Principle
1	**Nickel**	**Magneto-striction**
2	**Ceramic**	**Electro-striction**

The quality of transducers may vary considerably and is measured by their efficiency to transform electrical energy into sound waves and vice versa.

Receivers

The function of the receiver is to **amplify** the *weak electrical oscillations produced in the transducer by the echo* so that they can be recorded or displayed. The weak electrical signals produced in the transducer when echoes are received must be amplified several thousand times before being passed on to the recorder. This amplification takes place in the receiver and the amount of amplification can be decided by the sensitivity control.

Recorders

The recorders are responsible for displaying and recording of the echos in different forms like paper recorder, a flash-light display, an audible signal or an oscilloscope (Cathode Ray Tube (CRT)). Modern echosounders often use a colour monitors to show the echoes, In recent years , most advanced, light weight displays such as LCD and LED are used in echosounders, with that the crystal clear visibility of the display is possible even under the direct sunlight.

Installation of Ecosounders

Positioning and installation of the transducer are often decisive in ensuring proper performance. Normally the transducer should be placed between **one third and one half of the vessel length** from the bow and approx. **one metre away from the keel**.

In vessels smaller than 30 m the *transducer may be closer to the keel*. Noise may considerably reduce the efficiency of echo sounding and it is therefore of the greatest importance to avoid or reduce noise as far as possible.

The surface of the transducer should always be tilted **3° forward** in order to prevent turbulence on the transducer itself while underway.

Maintenance of transducer of echosounder

- Transmitter and receiver do not require routine maintenance
- Transducer should be inspected and its surface to be cleaned whenever possible
- Transducer face must be kept free from growth of seaweed or fouler in order to function properly.
- Scratching of surface with hard sharp instrument will damage the soft parts, so use only wood pieces for cleaning the surface of transducer.
- Do not paint the transducer's face.

Chapter 2: SPEED LOGS

Introduction

Speed logs are basic requirement for successful navigation. The navigator must know his vessel speed, which is useful in calculating right time of arrival to the destination and distance travelled by the vessel. The speed is also required to calculate his approximate position at sea. The speed log is a device used to measure the speed of a moving vessel. Generally the unit used for expressing the speed of a vessel is knots (Nautical miles/hour). Logs are used on vessels to record the speed and also the number of nautical miles the vessel has travelled through the water in a given time.

Speed log are generally classified in to two types

a. Conventional logs
b. Modern logs

CONVENTIONAL LOGS

Chip log or Ship log

The ship log was made with a quadrant (quarter circle) shaped wooden board attached to a log line. Log line was knotted at regular intervals and attached to the board with a bridle of three lines connected to the holes made at uniform spacing on the board. Just to ensure that the wooden log properly floats in water, the lower side of the board was made of lead or piece of lead at the centre of the circular side. The log line was wound on a free turning reel.

Operation of chip log or ship log

When the sailor wanted to determine speed, the log chip was thrown overboard where it floated vertically due to its ballasting. A considerable length of log line was let out to get the log chip into undisturbed water astern, where its resistance to forward motion keeps it essentially stationary in water (the wooded plank stay at the same place in water). As the ship moved forward, the line was pulled off the reel.

This was usually a 30 second timer and gave far more accurate results. Markings were made on the log line which represented the distance travelled by the ship.

A sand glass was also used to measure the time taken by the ship to move away from the chip log. According to the length of the log line released over the stern and the markings on the line, the speed of the ship was calculated.

MODERN LOGS

1. RPM Counter

The engine revolution counters provide a convenient means of determining speed and distance. They automatically count the revolutions of the **propellers**, and show the total count continuously on their dials. By means of a **master counter**, average revolutions made by the propellers can be obtained.

2. Pitometer log / Pressure log / Pilot tube

The pitometer log is similar to that of a **pilot tube** of an aircraft. A long tube called Rodmeter, is the main part of this log that protrudes from the hull of the ship. Rodmeter has two faces, one facing the direction of the sea water flow and the other is perpendicular to the flow.

The face of the opening in the direction of sea water flow measures the **dynamic seawater pressure** whereas the perpendicular face measures the **static seawater pressure**. A difference of both these pressures is used to measure the ship's speed.

For measuring the speed of the ship, ***both the static and dynamic pressures are added*** and the velocity of water is found out. However, the result is not accurate when the ship is moving with slow speed, as the difference in pressure is very less. The speed is measured by the variation of the pressure in the tube. This is not a very sensitive device.

Parts of Pressure Log

A typical pressure log consist of the following components,

1. Two openings outside the hull of the ship, **static tube** that provides static pressure and **impact or Pilot tube** that measures dynamic pressure or the water flow of pressure (Rodmetcr)
2. Controller unit (pressure differentiator)
2. Speed and distance transmitter
3. Speed and distance recorder

Operations

The opening of the Pilot tube faces forward so that when the vessel moves forward, the water causes a pressure at the tube this dynamic pressure is proportional to the speed at which the vessel moves.

The pressure differentiator measures the differential pressure.

The Controller unit converts the pressure difference into speed and distance units.

This type of log can give only speed through water and is greatly affected by the movement of the water which would induce an extra pressure giving rise to error in readings.

3. Impeller log

An impeller or small propeller that projects outside the vessel's hull below the bottom of the boat. The movement of the vessel's hull through the water causes the impeller to rotate.

The rotation of impeller produces the electric impulse, the output of the generator is amplified (that is proportional to the counts or revolutions of impeller) and that is translated into distance and speed. The speed and distance readings are *repeated at remote indicators* by means of an *electrical synchro-transmission*. However, the projection below the boat is liable to be damaged by gear and debris floating in water.

The Impeller Log is fitted in small sized vessels including fishing vessels. A typical impeller log contains the following components,

1. The log tube sensor assembly
2. The amplifier
3. Speed indicator and distance counter

The sensing device is a **long-tube** consisting of a small rotating device called impeller which is projecting into the water. The tube has the opening facing forward. On the movement of vessel, the water flow drives the impeller and the **rotation induces an electrical signal**. The output is fed to the **amplifier** and is used to operate the speed and distance **indicator**.

When the speed measurement is required, the log tube is lowered into the water, and when not in use, is retracted inside the hull. Retraction of the log can be done manually or by a remotely operated arrangement operated from the wheel house. The log-tube may be blocked with foreign bodies such as small fish, seaweed, debris etc. This log requires periodical cleaning.

4. Induction log or Electromagnetic speed log or Em log

The electromagnetic speed log also called as induction log or EM log measures the electromagnetic induction generated in sea water by its movement relative to magnetic field by the electrodes fitted in the hull of a vessel.

The sea water acts as the conductor and generates an emf..

Electromagnetic Speed Log is highly accurate in indication of speed though the water even at low speeds.

Two electrodes are mounted athwart ships and the emf (50-400 micro volts) induced in them is proportional to the speed of the vessel.

This method of measuring a ship's speed has been found to be accurate, economic and simple.

Principle

The flow of a conducting seawater past a sensor causes electromagnetic induction in the sensor which can be measured and which is proportional to the speed of the flow of the water.

A typical EM log consists the following parts-

1. Master Indicator
2. Pre-amplifier
3. Sensor

Operation of Electromagnetic Log

EM log consists of two electrodes placed beneath the hull. Magnetic field is produced by an electromagnet. In the electromagnetic log, the potential difference generated in water by its movement relative to the magnetic field is sensed by the electrodes. The current induced in these electrodes by the water flowing past is a function of speed. The measurement of speed of a ships by this log has been found to be accurately economic and simple.

As the vessel moves, the sea water (conductor) relatively moving through the magnetic field induces a small electromagnetic field into it. This emf is detected and measured by two sensors on the hull region.

The speed indicator signal is supplied to special generator which produces a number of pulses per minute which is proportional to the speed (say 200 pulses per nautical mile). This generator is connected to a distance run recorder which counts off the pulses and hence the number of miles travelled .Accuracy of indicated distance is about 1-2% of the distance travelled.

Advantages

i. The sensor device doesn't project beyond the bottom of the ship.
ii. EM log operates with greater accuracy and can measure smaller ship speeds.
iii. Receiving device does not require regular maintenance.
iv. Small in size.

Disadvantage: It cannot be used in freshwater.

5. Doppler log:

Doppler Log works with the principle of Doppler Effect. When a sound beam is transmitted from a moving vessel, difference (shift) in the frequencies is observed between transmitted sound and its reflected echo from a target. This frequency shift is known as the "Doppler Shift". The degree of shift in the frequency is proportional to the speed of the vessel.

The advantage of Doppler log is that it can indicate speed relative to seabed rather than speed through the water. Doppler shift of frequency of sound wave is due to movement of the transmitter (ship) is used to measure the speed of the ship.

In the case of echo sounder sound beams are sent vertically downwards, but in the Doppler log the transducers are angled horizontally about 60° to the keel. The propagation time of the pulse and its echo plays no role.

Depending on the size of the vessel up to **four transducers** are fitted. The frequencies usually vary between **100 kHz** and **1 MHz.** Accuracy is affected by temperature and salinity of the water (which alter the speed of propagation) and Doppler logs may have sensors to monitor and correct for variations in these parameters.

ARPV = Advanced Remotely Piloted Vehicle

SVDR = Simplified Voyage Data Recorder

Block diagram of Doppler Log

Working Principle

A transmitting transducer below the ship continuously emits a beam of sound vibrations in the water at an angle (usually 60˚ to the keel) in the forward direction. A second transducer aboard receives the echo caused by diffuse reflection from the seabed. A Doppler log uses a higher frequency than an echo sounder.

SIGNALS AND AIDS TO NAVIGATION

Chapter 1: Rules of the Road

Introduction

With the accelerated pace of technical and economical development in the shipping industry, there exists no area in accessible to modern vessels with the increase in size of vessels, the chances of accidents have become more especially in areas of lightly congested routes.

The International regulations of shipping act is changed periodically by the **Inter-Governmental Maritime Consultative Organization (IMCO)**.

Rules of the Road: Internationally agreed-on traffic regulations for ocean waters, a set of customary practices, especially for the operation of a motor vehicle, boat, or aircraft, established to promote efficiency and safety. Various regulations imposed upon travellers by land or water for their mutual convenience or safety. Any of the rules making up a code governing ships as to the lights to be carried, the signals to be made and the action of one ship with respect to another when risk of collision exists.

International Regulations for Preventing Collisions at Sea or **Rules of the road** are a set of statutes designed to promote navigational safety given by United Nations Convention on the Law of the Sea (**UNCLOS**). It provides requirements for navigation lights, day shapes, steering and sailing rules, sound signals in good and restricted visibility condition, and distress signals, among other things.

International Regulations for Preventing Collisions at Sea, was framed in **1972** and they came to practice only from **1977**. In total, there are about 38 rules, of which few are important as far as fishing vessels are concerned.

Part - A – GENERAL (Rule: 1-3)

Rule 1 – Application

Rule 2 – Responsibility

Rule 3 – General definitions

a) **Vessel** – includes every description of water craft, including non-displacement craft and seaplanes, used or capable of being used as a means of transportation on water.
b) **Power driven vessel** – means any vessel propelled by machinery.
c) **Sailing vessel** – means any vessel under sail provided that propelling machinery, if fitted is not being used.
d) **Vessel engaged in fishing** – means any vessel fishing with nets, lines, trawls or other fishing apparatus which restrict manoeuvrability, but does not include a vessel fishing with trolling lines or other fishing apparatus which does not restrict manoeuvrability.
e) **Seaplanes** – includes any aircraft designed to manoeuvre on the water.
f) **Vessel not under command** – means a vessel which through some exceptional circumstances is unable to manoeuvre as required by these rules and is therefore unable to keep out of the way of another vessel.
g) **Vessel restricted in her ability to manoeuvre** – means a vessel which from the nature of her work is restricted in her ability to manoeuvre as required by these rules and is therefore unable to keep out of the way of another vessel

The term vessel restricted in their ability to manoeuvre shall include but not be limited to a vessel engaged in:

i. Laying, servicing / picking up a navigation mark, submarine cable or pipe line
ii. Dredging, surveying or under water operations
iii. Replenishment or transferring persons, provisions or cargo while underway
iv. The launching or recovery of aircraft.
v. Mine clearance operations
vi. A towing operation such as severely restricts the towing vessel and her tow in their ability to deviate from their course.

h) **Vessel constrained by her draught** – means a power – driven vessel which, because of her draught in relation to the available depth and width of navigable water, is severely restricted in her ability to deviate from the course she is following.
i) **Under way** – means that a vessel is not at anchor, or made fast to the shore or aground.
j) **Length and breadth** – of a vessel means her length overall and greatest breadth.
k) **Restricted visibility** – means any condition in which visibility is restricted by fog mist, falling snow heavy rains forms sand storms or any other similar cause.

PART-B: STEERING AND SAILING RULES (Rule: 4-19)

SECTION-I Conduct of vessels in any condition of visibility

Rule 4 – Application – Rules in this section apply to any condition of visibility

Rule 5 – Look out – Maintain proper lookout by sight and hearing.

Rule 6 – Safe speed – Every vessel shall maintain safe speed to avoid collision and to effective action on the sea.

In determining safe speed the following factors shall be among those taken into account.

i. The state of visibility
ii. The traffic density including concentrations of fishing vessels or any other vessels
iii. At night the presence of background light such as from shore lights or from back scatter of her own lights.
iv. The state of wind, sea and current and the proximity of navigational hazards
v. The draught in relation to the available depth of water

Rule 7 – Risk of collision

Rule 8 – Action to avoid collision

Rule 9 – Narrow channels

Rule 10 – Traffic separation schemes **-** (Traffic lanes)

SECTION-II – Conduct of vessels in sight of one another

Rule 11 – Application

Rule 12 – Sailing vessel **–** (Rules when two sailing vessels approaching one other)

Rule 13 – Overtaking

Rule 14 – Head-on situation

Rule 15 – Crossing situation

Rule 16 – Action by give way vessel

Rule 17 – Action by stand – on vessel

Rule 18 – Responsibilities between vessels.

SECTION-III

Rule 19 - Conduct of vessels in restricted visibility

PART-C: LIGHTS AND SHAPES

Rule 20 - Application

Rule 21 – Definitions (Definitions for navigational lights)

a. **Masthead light** – means a **White** light placed over the fore and aft centerline of the vessel showing an unbroken light over an arc of the horizon of 22.5 degrees and so fixed as to show the light from **right ahead** to **22.5** degrees **abaft** the **beam** on either sides of the vessel.

b. **Side lights –** means a **Green** light on the **Star board** side and a **Red** light on the **Port side** each showing an unbroken light over an arc of the horizon of **112.5 degrees** and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on it respective side.

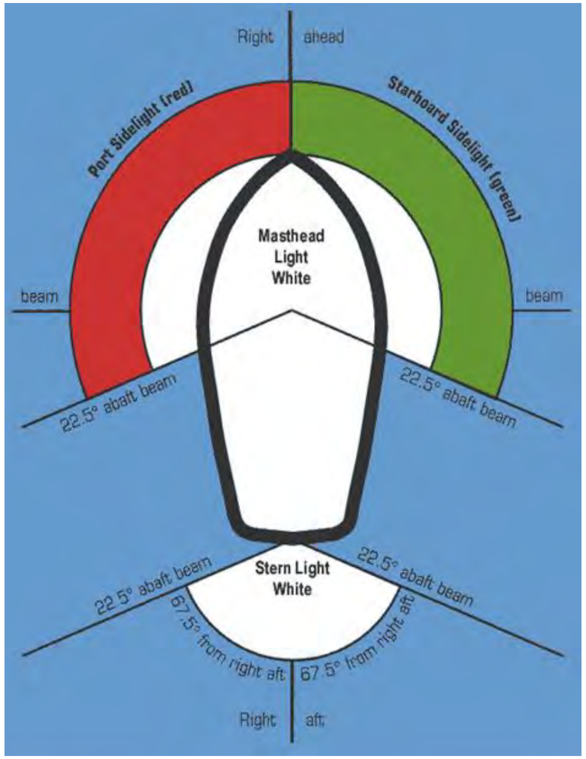
   In a vessel of less than 20 meters in length the side lights may be combined in one lantern carried on the fore and aft centerline of the vessel.

c. **Stern light –** means a **White** light placed as nearly as practicable at the stern sharing an unbroken light over an arc of the horizon of **135** degrees and fixed as to show the light **67.5 degrees from right aft** on each side of the vessel.

d. **Towing light –** means a **Yellow** light having the same characteristics as the stern light defined in © of this rules

e. **All round light** – means a light showing an unbroken light over an arc of the horizon of **360 degrees**.

f. **Flashing light** – means a light flashing at regular intervals at a frequency of **120 flashes** or more **per minute**.



Rule 22 – Visibility of lights (in nautical miles)

	Length of vessel		
Nature of light	**More than 50m**	**12- 50 m**	**Less than 12m**
Mast head light	6	5	2
Side light	3	2	1
Stern light	3	2	2
Towing light	3	2	2
All round light	3	2	2

Rule 23 – Power driven vessels underway

Rule 24 – Towing and pushing

Rule 25 – Sailing vessels underway and vessels under oars

Rule 26 – Fishing vessels

A vessel engaged in **fishing**, whether **underway** or **at anchor**, shall exhibit only the lights and shapes prescribed in this rule.

a) A vessel engaged in trawling exhibits:

i. Two all-round lights in a vertical line the **upper** being **green** and the **lower white** or a shape consisting of **two cones with their apexes together** in a vertical line one above the other (day time).

ii. A masthead light abaft of and higher than the all-round green light (a vessel of more than 50 mts in length)

iii. If making way through the water in addition to the above, paragraph sidelights and a stern light exhibited

b) A vessel engaged in fishing, other than trawling exhibits:

i. Two all-round lights in a vertical line, the **upper** light being **red** and **lower white**, or
   a shape consisting of two cones with apexes together in a vertical line one above the other in **day time.**

ii. When there is outlying gear extending more than **150mts** horizontally from the vessel, an all-round **white** light or a **cone apex upwards in the direction of the gear.**

iii. When making way through the water, in addition to above, paragraph side lights and a stern light.

c) Additional signals

[I] Signals for trawlers

1. **Vessels engaged in trawling** (20 mts or more in length when whether engaged in trawling or using demersal or pelagic gear)

i. **When shooting their nets – two white** lights in a vertical line
OR international code flag "**Z**" (**ZULU**), in day time.

ii. **When hauling their nets** – one **white** light **over** one **red** light in a vertical line
OR international code flag "**G**" (**GOLF**), in day time.

iii. **When the net has come fast upon an obstruction – two** all-round **red** light in a vertical line
OR international code flag "**P**" (**PAPA**), in day time.

2. **Vessels engaged in pair trawling** (each 20mts or more in length)
   i. By night, a searchlight directed forward and in the direction of the other vessel of the pair;
   ii. When shooting or hauling their nets or when their nets have come fast upon an obstruction, the lights prescribed in Rule 26 (a) above.

[II] **Signals for purse seiners** – may exhibit two yellow lights in a vertical line. These lights shall flash alternately every second.
(with equal light and occultation duration. These lights may be exhibited only when the vessel is hampered by its fishing gear).

Rule 27 – Vessels not under command or restricted in their ability to manoeuvre.

Rule 28 – Vessels constrained by their draught

Rule 29 - Pilot vessels

Rule 30 – Anchored vessels and vessels aground

Rule 31 – Seaplanes

PART - D – SOUND AND LIGHT SIGNALS

Rule 32 – Definitions

a. **Whistle –** means any sound signalling appliance capable of producing the prescribed blasts and which complies with the specification – frequency lie within the range of **70-700 Hz**.

b. **Short blast** – means a blast of about **one second**'s duration

c. **Prolonged blast** – blast of from **four to six seconds** duration

Rule 33 – Equipments for sound signals

Rule 34 – Manoeuvring and warning signals

Rule 35 – Sound signals in restricted visibility

Rule 36 – Signals to attract attention

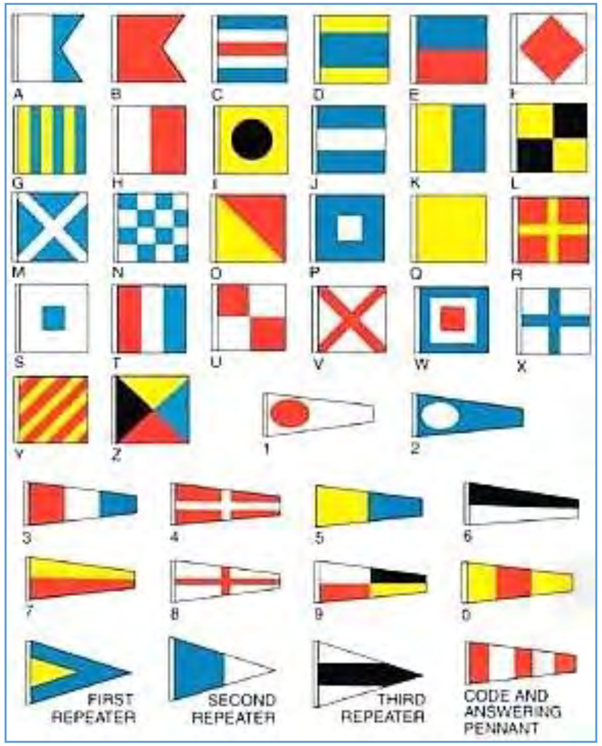
Rule 37 – Distress signals

Chapter 2: Navigational signals

Signals

Signals are means of communication of a piece of information by an action, gesture, or sign. Signals are used to convey or transmit a message to others. The basic principles of Code is that each signal should have a complete meaning and this principle is followed throughout the Code.

International Code of Signals (ICS)



First international code was introduced in ***1855*** by a committee set up by the ***British Board of Trade***. It contained ***70,000*** signals. These codes of signals were revised during 1887 and 1927 for two times.

In **January 1959**, the **1st** assembly of ***International Maritime Organization (IMO)*** decided that the organization should assume all the functions being performed by the standing committee of International Code of Signals.

The code was adopted by the **4th**Assembly of IMO in **1965**.

Purpose of ICS

-To provide ways and measures of communication in situations related to safety of navigation and persons especially in case of language difficulties.

- In the case of radio telephony and radio telegraphy, which provide simple and effective means of communication in plain language, where there is no language difficulties.

The code of signals consists of:

1. **Single-letter** signals allocated to significations which are very ***urgent***, important, or of very common use.

2. **Two-letter** signals for the ***General Section***.

3. **Three-letter** signals beginning with "**M**" for the ***Medical Section*** to exchange message between ships carrying a doctor and one not carrying on the treatment, condition, diagnosis of a sick or injured person.

Some Important Terminologies Used in Signalling:

Visual signalling is any method of communication the transmission of which is capable of being seen.

Sound signalling is any method of passing **Morse signals** by means of siren, whistle, foghorn, bell, or other sound apparatus.

Originator is the authority who orders a signal to be sent.

Identify signal or **call sign** is the group of letters and figures assigned to each station by its administration.

Station means a ship, air craft, survival craft or any place at which communication can be effected by any means.

Addressee is the authority to whom a signal is addressed.

Group denotes more than one letter or numeral which together composes a signal.

Numerical group consists of one or more numerals.

Methods of Signalling

1. Flag signalling
2. Flashing light signals using the Morse symbols
3. Sound signalling using Morse symbols
4. Voice over a loud hailer
5. Radio telegraphy
6. Radio telephony
7. Morse signalling by hand – flags or arms

Flag Signalling

- Signal flags are used to communicate the messages.
- A set of signal flags consists of **26** alphabetical flags, **10** numerical pennants, **3** substitutes and **1** answering pennant.
- There is also a signalling system called **Semaphore** which uses the position of the flags relative to a person to denote the letter.

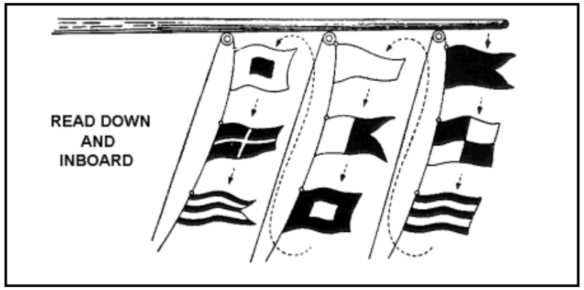
✓ As a general rule only one hoist should be shown at a time. Each hoist or group of hoists should be kept flying until it has been answered by the receiving station.

✓ If the receiving station cannot clearly distinguish the signal made to it, if it can distinguish the signal but cannot understand the purpose of it, it can hoist the following signals.

✓ When **more than one groups** are shown on the same **halyard** they must be separated by a **tack line**.

✓ The transmitting station should always hoist the signal where it can be most easily seen by the receiving station, that is, in such a position that the flags will blow out clear and be free from smoke

How to Call



The identity signal of the station(s) addressed is to be hoisted with the signal If no identity signal is hoisted it will be understood that the signal is addressed to all stations within visual signalling distance.

How to answer signals

All stations to which signals are addressed or which are indicated in signals are to hoist the answering pennant at the dip as soon as they see each hoist and close up immediately, when they understand it; it is to be lowered to the dip as soon as the hoist is hauled down at the transmitting station, being hoisted close up again as soon as the next hoist is understood.

How to complete a signal

The transmitting station is to hoist the answering pennant singly after the last hoist of the signal to indicate that the signal is completed. The receiving station is to answer this in a similar manner to all other hoists

How to act when signals are not understood

If the receiving station cannot clearly distinguish the signal made to it, it is to keep the answering pennant at the dip.

If it can distinguish the signal but cannot understand the meaning of it, it can hoist the following signals: **“ZQ”** = “Your signal appears incorrectly coded.

You should check and repeat the whole”, or “**ZL”** = “Your signal has been received but not understood”.

The Use of Substitutes

The use of substitutes is to enable the same signal flag, either alphabetical flag or numeral pennant, to be **repeated** one or more times in the same group, in case **only one set of flags is carried** on board.

The **first substitute** always repeats the **uppermost** signal flag of that class of flags which immediately precedes the substitute.

The **second substitute** always repeats the **second** and the **third substitute** repeats the **third** signal flag, counting from the top of that class of flags which immediately precedes them.

No substitute can ever be used more than once in the same group. The answering pennant when used as a decimal point is to be disregarded in determining which substitute to use.

Example:

The signal “**NN**” would be made as follows:

N

first substitute

The number **“3300”** would be made by numeral pennants as follows:

3

first substitute

0

third substitute

The use of substitutes

The use of substitutes is to enable the same signal flag – either alphabetical flag or numerical pennant to be repeated one or more times in the same group in case only one set of flags are carried on board.

The first substitute always repeats the upper most signal flag of that class of flags which immediately precedes the substitute.

The second substitute always repeats the second and the third substitute repeats the third signal flag, counting from the top of that class of flags which immediately precedes them.

Signalling by hand flags or arms (Semaphore)

There is also a signalling system called **Semaphore** which uses the position of the flags relative to a person to denote the letter.

1. Raising both hand flags or arms – Dot

2. Spreading out both hand –flags or arms at shoulder level – Dash

3. Hand flags or arms brought before the chest – Separation of dot and/or dash

4. Hand flags or arms kept at 45^o away from the body down wards – Separation of letters groups or word

5. Circular motion of hand – flags or arms over the head – Erase signals or request for repetition

Flashing Light Signalling

Specially prepared flashing lights are used for the signals at sea. Flash lights are used only during night hours. Most of the signal lights are unidirectional. The standard rate of signaling by flashing light is to be regarded as **40 letters per minute**.

In selecting a flashlight, ensure that it is water resistant and that it is designed to withstand shocks and also seals out moisture. The case should be made of non-slip rubber. A red plastic disc should be inserted in the lighted end to provide a red light for sustaining your night vision or to prevent unnecessarily lighting up the bridge at night

Sound Signalling

Sound producing apparatus such as whistle, siren and fog horn are used for sound signalling at sea.

Sound signalling is required at the time of restricted visibility.

Signals other than the single letter signals should be used only in extreme emergency and never in frequented navigational waters.

The signals should be made slowly and clearly. They may be repeated, if necessary, but at sufficiently long intervals to ensure that no confusion can arise and that one letter signals cannot be mistaken as two-letter groups.

The Morse symbols representing letters, numerals, etc., are expressed by dots and dashes which are signalled either singly or in combination. The dots and dashes and spaces between them should be made to bear the following ratio, one to another, as regards their duration:

(a) A dot is taken as the unit;

(b) A dash is equivalent to three units;

(c) The space of time between any two elements of a symbol is equivalent to one unit; between two complete symbols it is equivalent to three units; and between two words or groups it is equivalent to seven units.

Radio telephony

Message transmission through radiotelephone is used only when there are no language difficulties. When radiotelegraphy or radiotelephony is used for the transmission of signals, operators should comply with the Radio Regulations of the International Telecommunication Union .Plain language should be used for easy understanding. Letters and figures are to be spelt in accordance with spelling table.

Eg:

DE – Delta Echo

AA - Alfa Alfa

BN – Bravo November

WB – Whiskey Bravo

Distress Transmitting Procedures

We can send the distress message through radiotelephone when we are looking for immediate assistance. 2182 khz and 500 khz are the general calling and reply to call frequencies in the MF R/T marine band and MF telegraphy band respectively. Following is the standard format for sending distress message through radiotelephone

1. Tune the radiotelephone to frequency **2182 kHz.**
2. If possible, transmit the **ALARM SIGNAL** (i.e. two-tone signal) for **30 s**econds to **1 m**inute, but do not delays the message if there is insufficient time in which to transmit the Alarm signal.
3. Send the following **DISTRESS CALL**.
4. Mayday Mayday Mayday. This is..(name or call sign of ship spoken three times).
5. Then send the **DISTRESS MESSAGE** composed of:

Mayday followed by the name or call sign of ship;

Position of ship;

Nature of distress;

And, if necessary, transmit the nature of the aid required and any other information which will help the rescue.

Wait for any reply message, if there is no reply repeat the procedure once again and till you get any response from port or any vessel.

USE PLAIN LANGUAGE WHENEVER POSSIBLE.

Voice over a loud hailer

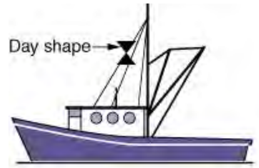
Whenever possible plain language should be used but where a language difficulty exists groups from the International Code of Signals could be transmitted using the phonetic spelling tables

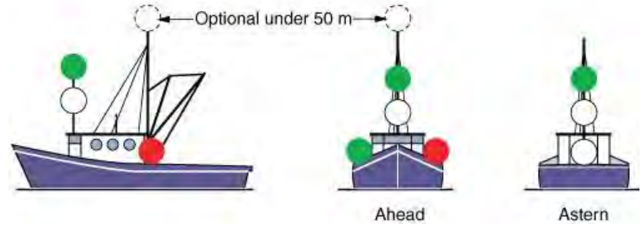
Shapes

During daylight hours vessels should display a black shape or shapes that assist other vessels to identify them and assess what activity they are engaged in, and consequently their ability to maneouvre.

A vessel at anchor should display a black sphere, in the case of a sailing vessel it is usually hoisted on the front stay.
A sailing vessel that is motor sailing should display an inverted black cone. Usually displayed on the front stay.
A vessel that is not under command should display two black spheres, one vertically above the other.
A fishing vessel should display two black cones one vertically above the other, the upper one should be inverted.
If a fishing vessel has nets out 150metres or more, an additional black cone should be displayed on the side of the vessel from which the nets are extended.
A fishing vessel may sometimes use a basket instead of the normal shape.
A vessel that is constrained by draught, should display a black cylinder. However they often neglect to do so.
When a vessel is engaged in towing another vessel and the tow is 200 metres or over in length. Both vessels should display a black diamond.
A vessel that is unable to manoeuvre, should display two black spheres and a black diamond. Hoisted vertically one above the other, with the diamond taking centre place.

Signals for fishing Vessels (Light and Shapes)





Fishing vessel:

A vessel engaged in fishing whether at underway or anchor shall exhibit only the lights and shapes prescribed in this rule.

a) Trawling:

A vessel when engaged in trawling by which is meant the dragging though the water of a drudge net or other apparatus used as fishing appliances shall exhibits.

(i) Two all round lights in a vertical line, the upper being green and the lower white or a shape consisting two cones with their apex together, in a vertical line one above the other.

(ii) A small mast head light abaft of and higher than the all round green light a vessel of less than 50m is length, shall not obliged to exhibit such a light may do so.

(iii) When making way through the water in addition to the light prescribed in this paragraph, side lights and stun lights.

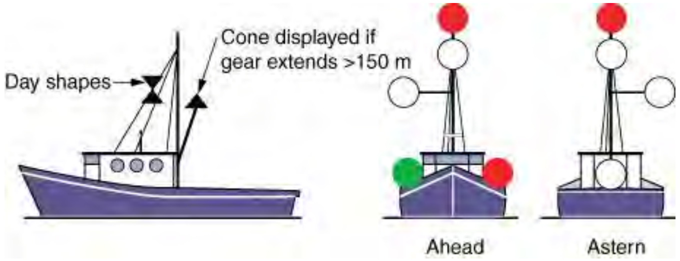
(b) A vessel engaged in fishing other than trawling shall exhibit.

(i) Two all round lights in a vertical line, the upper being red and lower light white or shape consisting of two cones with apices together in a vertical line one above the other.

(ii) When there is a outlaying gear extending more than 150m horizontally from the vessel and all round white light or cone apex upwards in the direction of the gear.

(iii) When making way through the water. In addition to the light prescribed above this paragraph side lights and streetlights

Additional signals



(i) Signals for trawlers:

When shooting their nets, 2 white lights in a vertical position, when hauling their nets one white over one red light in a vertical line.

(ii) In pair trawling or bull trawling by night; a search light, directed forward in direction of other vessels.

(iii) Singles for purse seines:

Two yellow lights in a vertical line shall flash alternative.

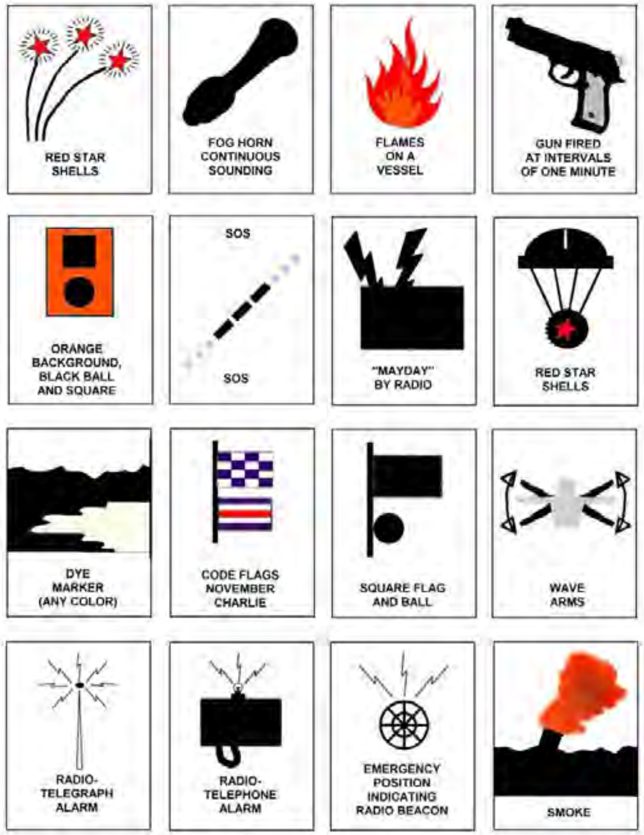
Reception of Safety Massages

Any message which you hear prefixed by one of the following words concerns **SAFETY**

MAYDAY	**(Distress)**	Indicates that a ship, aircraft or other vehicle is threatened by grave and imminent danger and requests immediate assistance
PAN PAN	**(Urgency)**	Indicates that the calling station has a very urgent message to transmit concerning the safety of a ship, aircraft or other vehicle, or the safety of a person
SECURITE	**(Safety)**	Indicates that the station is about to transmit a message concerning the safety of navigation or giving important meteorological warnings.

If you hear any of these words, pay particular attention to the message and call the master of the officer on watch.

Distress Signals



Distress signals

Distress means extreme pain or great danger or difficulty, with a need for immediate assistance. A **distress signal** is an internationally recognized means for obtaining help

Distress signals take the form of or are commonly made by using radio signals, displaying a visually detected item or illumination, or making an audible sound, from a distance.

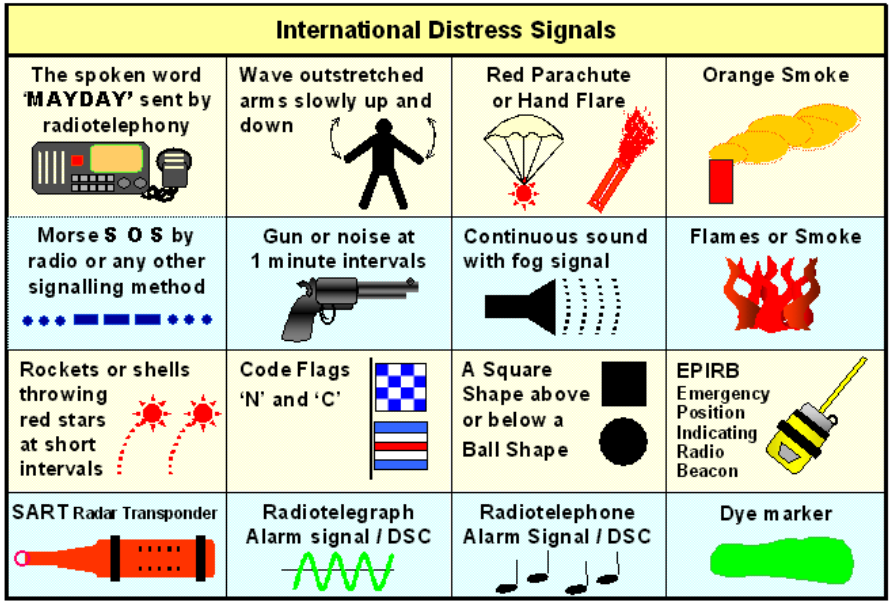
A distress signal indicates that a person or group of people, ship , aircraft , or other vehicle is threatened by grave and imminent danger and requests immediate assistance.

Following signals are to be used or displayed, either together or separately, by a vessel (or seaplane on the water) in distress requiring assistance from other vessels or from the shore

BY DAY

1. A gun or other explosive signal fired at intervals of about a minute
2. The International code signal of distress indicated by NC (NC = I am in distress and require immediate assistance)
3. A signal consisting of a square flag having above or below it a ball or anything resembling a ball.
4. Continuous soundings or any fag signaling apparatus
5. Radiotelephone signal consisting of the spoken word "MAY DAY" (Maidez – Freruch wird – meaning come and help)
6. The signal SOS made by radiotelegraphy (save our soul).
7. Orange Distress Flag
8. Radio telephone or telegraph alarm signal (12 dashes/min).
9. Slowly and repeatedly rising and lowering of arms outstretched on either side
10. Signals transmitted by emergency position indicating radio beacons.

BY NIGHT



1. Rockets or shells throwing red stars
2. Flames on the vessel as from as burning tar barrel, oil barrel etc
3. Rocket parachute or hand flare showing a red star
4. Orange coloured smola signal

The use of any of the above signal except for the purpose indicating distress and the need of assistance is prohibited. Whoever commits a breach of the above rule is liable for a fine upto Rs. 1000/-.

Distress signals are to be used only upon master's orders.

The signals must be revoked if assistance is no longer required.

Duties of master during distress

- Master must help/assist every person at sea in danger even if that person is from an enemy state.

- He must go to distressed area and analyzes the situation / take quicken decisions/action.

- Give distress signals.

Storm Signals

The meteorological department sends storm warnings (by mean of high priority telegrams) to port officers whose ports are likely to be affected by adverse weather.

Port officers display visual storm signals, on conspicuous masts specially meant for this purpose. The signals consist of black coloured cones and cylinders by day and of red and white lights by night. The port officers also send word to fishing vessels and country craft in their respective ports.

Chapter 3: Aids to Navigation

Aids to Navigation

The term "aid to navigation" means any object or device, external to a vessel, that is intended to assist a navigator in fixing his position or determining a safe course past hazards to navigation. It includes both fixed and floating objects such as lights, light ships, buoys, day beacons, and fog signals, plus electronic aids to navigation such as radio beacons. Navigational aids take a wide variety of forms, some are very simple unmanned objects, others are complex and costly devices sometimes with operating crews in attendance. All serve the same goal – the safety of vessels and those on board . Aids to navigation are put at various points along the coasts and navigable waterways as markers and guides to help mariners determine their position. They also serve to warn of hidden dangers and assist in making landfall when approaching from the high seas. They also provide a continuous chain of charted marks, showing improved channels and assisting in coastal piloting. Prominent features ashore, both natural – such as mountain peaks-and manmade-such as water tanks and radio towers, may often assist the navigator in fixing his position or directing his course; these, however, are excluded from the definition of an "aid to navigation," which is considered to be an object established for that primary or sole purpose.

Importance of aids to Navigation

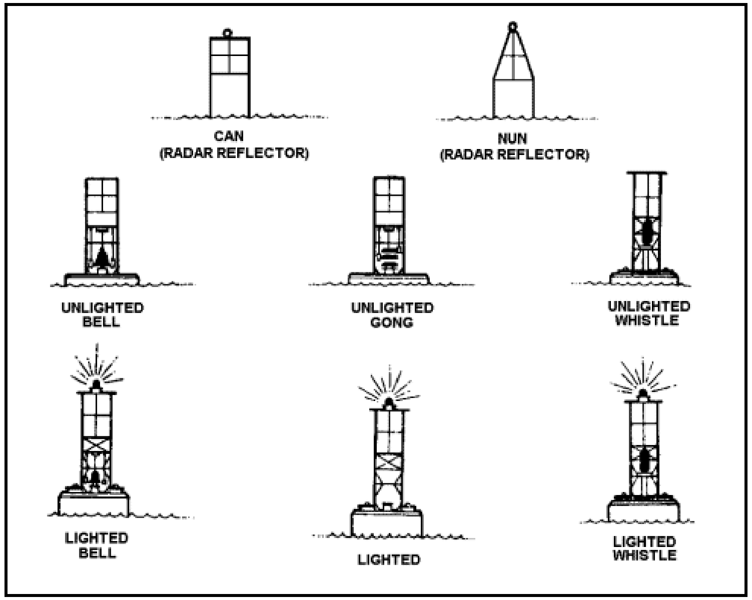
These aids are of tremendous assistance to the navigator in making a landfall when approaching from seaward, and in all coastal navigation. Their importance was first recognized by the ancient Mediterranean mariners; a lighthouse was built at Sigeum, near Troy, before 600 B.C., and the famous Pharos of Alexandria was built in the third century B.C. Wood fires furnished their illumination, and wood and sometimes coal remained in general use for this purpose until the eighteenth century. The first lighthouse in the United States was built at Boston in 1716, and logs and kegs were used as buoys in the Delaware River in 1767.

Aids to navigation take a wide variety of forms; some are very simple unmanned objects, others are complex and costly devices, sometimes with operating crews in attendance. All serve the same goal- the safety of vessels and those on board; difference in type, size, etc., are determined by the circumstances of location and use.

Buoys

Buoys are floating objects heavily anchored to the bottom that are intended to convey information to a navigator by their shape and colour, by the characteristics of a visible or audible signal or a combination of two or more such features. Buoys are perhaps the largest category of aids of navigation and come in many shapes and sizes. Lightships fit such a definition but form a separate category by themselves. Buoys detection at night; these reflect brightly in the beam of a vessel's searchlight. Many buoys have radar reflections. Buoys often have bands or patches of reflective material to enhance their detection at night these reflect brightly in the beam of a vessel's search light. Some buoys have radar reflections

Types of Buoys



There are several types of buoys, each type designed to meet the requirements of certain specific conditions. All buoys serve as guides during day light, those having lights are also available for navigation at night, and those having sound signals are more readily located in times of fog or other conditions of reduced visibility.

The following are the principal types of buoys

1. **Can buoy** : The shape of can buoys is cylindrical. A buoy of steel plates with the portion above water having the shape of a tin can, flat on top when seen from a distance.

2. Spar Buoys: These are large logs, trimmed, shaped, and appropriately painted. Although the Coast Guard has now eliminated them, spar buoys may still be found in some foreign or private systems of aids.

3. **Nun buoy**: The shape of nun buoys is conical A buoy built of steel plates with the portion above water terminating in a cone with a rounded tip.

4. **Lighted buoy**: These carry batteries or gas tanks and are surmounted by a framework supporting a light. A description of the lights on lighted buoys is given later. A steel float on which is mounted a shore skeleton tower at the top of which a light is placed. A set of electric batteries (or other sources of power) which operate the light, is placed in the body of the buoy.

5. **Bell buoy**: These have flat tops, surmounted by a framework supporting a bell. Older bell buoys are sounded by the motion of the sea. Newer types are operated automatically by compressed gas or electricity. A steel float topped with a short skeleton tower in which there is a bell fixed with several clappers-usually four- hung externally so that they will strike the bell as it rocks with the motion of the sea. A few shore stations and fixed aids to navigation have bells that are sounded by mechanical means, but at most locations these have been replaced by electrically operated horns.

6. **Gong buoy**: These are similar to bell buoys except that they have a series of gongs, each with a different tone. Generally similar in construction to a bell buoy except that rather than a bell it has several, usually four, gongs mounted in a vertical stack, each of which sounds a different note; each gong has its own clapper of a length so as to strike only that going.

7. **Whistle buoy**: These are similar to bell buoys except they carry a whistle sounded by the sea's motion or horns that are sounded at regular intervals by mechanical or electrical means.

A buoy generally similar in construction to a bell or gong buoy but which has a low-pitched whistle signal that is activated by the rise and fall of the buoy in a seaway. A horn buoy is must the same except that its sound signal is electrically powered by batteries within the lower part of the buoy.

8. **Combination Buoys:** These are buoys in which a light and sound signal are combined, such as a lighted bell, gong, or whistle buoy. Combination buoy, A buoy having a light signal and sound signal, such as a lighted bell buoy, a lighted gong buoy, etc. The overall shape and general physical characteristics of these buoys may be seen in fig.507.

9.Station buoys : Buoys do not always maintain exact positions; therefore, they should always be regarded as warnings and not as fixed navigational marks, especially during the winter months or when moored in exposed waters. A smaller nun or can buoy called a station buoy, is sometimes placed in close proximity to a major aid, such as a sea buoy, to mark the station in case the regular aid is accidentally shifted from station. Station buoys are colored and numbered the same as the major aid to navigation. Lightship station buoys bear the letters "LS" above the initials of the station.

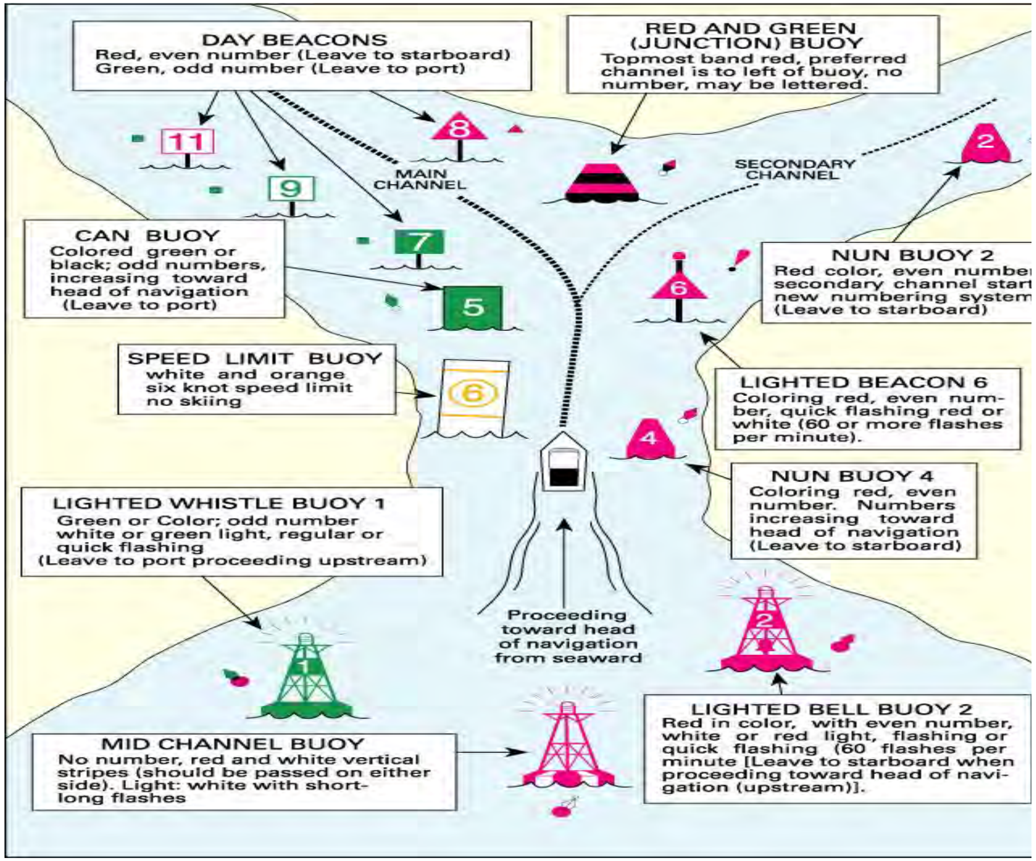
Unlighted buoys and day beacons are marked with reflective tape. This greatly facilitates locating the buoys at night with a searchlight. Reflective areas may be red, green, white, or yellow, and have the same significance as lights of these colours.

Importance/Significance of Buoys

System provides rules which apply to all fixed and floating marks (other than light houses, sector lights, leasing lights and marks, light ships) and they are serving to indicate.

The primary function of buoys is to warn the mariner of some danger, some obstruction, or change in the contours of the sea bottom, and to delineate the channels leading to various points; occasionally, a buoy may be placed offshore merely to assist a navigator in establishing his position before approaching a harbour (sea buoy). Valuable information is obtained from buoys when they are considered as marking definitely identified spots, for if a mariner knows his location at the moment and is properly equipped with charts, he can plot a safe course on which to proceed. Such features as size, shape, colouring, numbering, and signalling equipment of buoys are but means to warn, orient, and guide the navigator

Marine Buoyage System



Before 1976, there was no common buoyage system; there were about 30 different buoyage systems were in use throughout the world. Because of too many systems, confusions and misleading were resulted. During 1977, Inter-Governmental Maritime Consultative Organization (IMCO) introduced common buoyage system.

There are two types of buoyage system

system A → This system is followed by Europe, Australia, New Zealand, Africa, Gulf and some Asian countries.

System B → This is adopted in the countries such as North, Central and South America, Japan, Korea and the Philippines.

During 1980 International Association of Lighthouse Authorities (IALA) with the assistance of International Hydro graphic Organization (IHO) and Inter-Governmental Maritime Consultative Organization (IMCO) combined A & B system and introduced new system called IALA Maritime Buoyage system. In this system, there are 5 types of marks which may be used in combination. The mariner can easily distinguish between these marks by readily identifiable.

Only lateral marks differ between buoyage regions A and B, where as other 4 types are common to both the region.

Lateral Marks

Lateral marks – To indicate navigable channels

Generally used for well defined channels. These marks indicate the port and starboard sides of the route to be followed. The location of lateral buoys defines the borders of channels and indicates the direction.

Region A (Europe, Australia, New Zealand, Africa, Gulf and Asian countries)

They follow red colour buoy to port side and green colour to star board sides of channels.

Region B (North, Central and South America, Japan, Korea and the Phillippines)

They follow red colour buoy to port side and green colour to star board side green to port side. Under IALA A red buoys mark the port side of the channel when returning from sea, whereas under IALA B green buoys mark the port side of the channel when sailing towards land.

The general direction taken by the mariner when approaching a harbour river, estuary or other waterway from seaward.

Port mark

Meaning: when travelling upstream, leave port hand marks on your port side. When travelling downstream, leave port hand marks on your starboard side.

Colour: red.

Top mark: can shape

Light: a red light may be shown..

Starboard mark

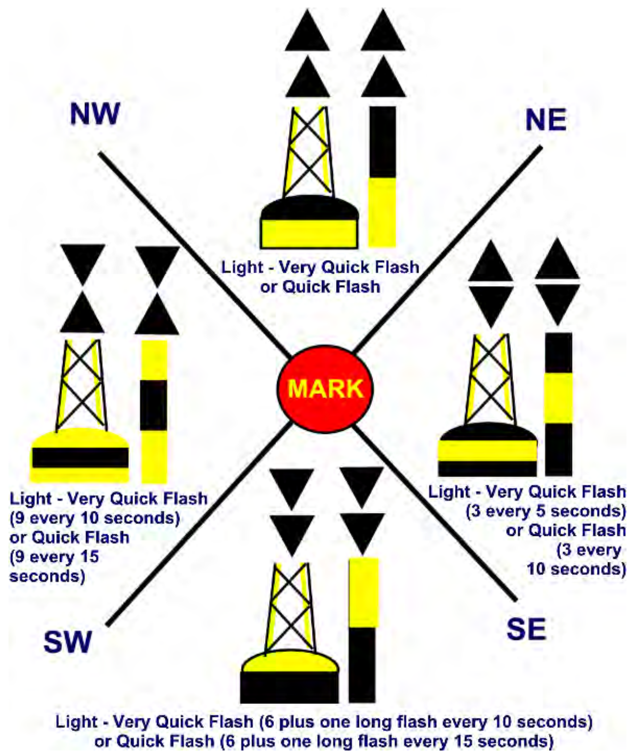
Meaning: w hen travelling upstream, leave starboard hand marks on your starboard side. When travelling downstream, leave starboard hand marks on your port side.

Colour: Green

Top mark: cone shape.

Light: a green light may be shown

Cardinal Marks



Cardinal marks used in conjunction with the mariner's compass to indicate where the mariner may find navigable water. Navigator may find the four chief points of compass where there is cardinal marks are anchored. Cardinal marks indicate that the deepest water in the area lies to the named side of the mark. The four cardinal buoys indicate the safe side of a danger with an approximate bearing. You should pass to the east of an East Cardinal mark, to the south of a South Cardinal, to the west of a West Cardinal and to the north of a North Cardinal. Cardinal marks do not have a distinctive shape but are normally pillar or spar. They are always painted in yellow and black horizontal bands and their distinctive double cone top-marks are always black. The cardinal system is identical in both the IALA A and IALA B buoyage systems

. Notice the "clockwise" resemblance of the light phase characteristics. **Lights (white)** the lights in individual quadrants have the following characteristics:

- 3 o'clock = **East Cardinal** = 3 flashes. VQ(3) or Q(3) with a blackout afterwards
- 6 o'clock = **South Cardinal** = 6 flashes + 1 long. VQ(6) or Q(6) with a long flash and a blackout
- 9 o'clock = **West Cardinal** = 9 flashes. VQ(9) or Q(9) with a blackout afterwards
- 12 o'clock = **North Cardinal** = continuous flashing. VQ or Q - continuous

The top marks consist of two black triangles placed in accordance with the black/yellow scheme of the buoy. The lights, top marks and colour schemes have a logic to help you memorise them. The cones on top point in the direction of the black segment of the pillar:

- **North** – (meaning**:** pass to North) both cones top point up, black at the top of the pillar.
- **East** –(meaning**:** pass to East) the cones point up and down, black at top and bottom.
- **South** –(meaning**:** pass to South) both cones point down, black at the bottom.
- **West** – (meaning**:** pass to West) the cones point inwards, black in the middle.

When a new obstacle (not yet shown on charts) needs to be marked, two cardinal buoys - for instance a South buoy and an East buoy - will be used to indicate this "uncharted" danger.

Isolated danger marks

Isolated danger marks to indicate isolated dangers or minor obstacles of limited size that have navigable water all around them.

They are black with horizontal red stripes. Distinctive double black spherical top marks one above the other and group flashing (2) white lights, serve to associate isolated marks with cardinal marks. . The light is white - a group flash light Fl(2) with two flashes in a group.

Isolated danger mark

Meaning: indicates isolated danger, a submerged object

with water all around, don't pass close.

Colour: black with one or more horizontal red bands.

Top mark: black spheres.

Light: white light showing a group of two flashes.

Safe water marks

Safe water marks are placed to indicate that there is navigable water all round their position like mid – channel marks (but it does not mark a danger or hazard). Spherical or alternatively pillar or spar with a single red spherical top mark. They are the only type of mark to have vertical strips (red and white).

Lights – isophase, occulting, one long flash or morse A rhythms. When the light is installed, then its colour is white and its rhythm may be isophase, occulting, long flash or the Morse Code letter "A".

Safe water mark

Meaning: t he water all around is free from obstruction of shallows.

Colour: red with white vertical stripes.

Top mark: single red sphere.

Light: single white long flash every ten seconds, isophase or occulting.

Special marks

Special marks not primarily intended to assist navigation but to indicate an area or feature referred to in nautical documents. Special marks are yellow. They may carry a yellow 'X' top mark, and light used is yellow. Special marks may also be lettered or numbered to indicate their purpose.

Special mark

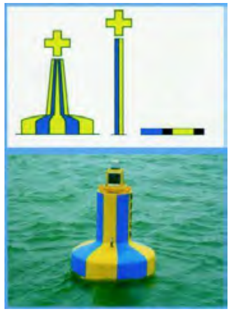
Meaning: indicates special area - could be spoil or foul ground marks, cable or pipeline marks, including outfall (sewage) pipes or a wreck.

Colour: yellow, at night yellow light.

Top mark: single yellow cross.

Light: yellow, any rhythm may be used other than those used for the white light of cardinal, isolated danger or safe water marks.

New danger marks



It should be specially noted that a 'new danger' which is one not yet shown in nautical documents, may be indicated by exactly duplicating the normal mark until the information is sufficiently promulgated. A new danger mark carry a Racon coded Morse 'D'. Attention is being drawn to the fact that a "new danger" that has not yet been announced in nautical documents may be indicated with a duplicating mark being identical (in all details) with the principal mark. The duplicating mark should stay until the news about the new danger has been adequately announced. The "new danger" mark should be equipped with a Racon sending out the letter "D" in the Morse Code

The emergency wreck marking buoy will remain in position until: a) the wreck is well known and has been promulgated in nautical publications; b) the wreck has been fully surveyed and exact details such as position and least depth above the wreck are known; and c) a permanent form of marking of the wreck has been carried out.

The buoy has the following characteristics:

- A pillar or spar buoy, with size dependant on location.
- Coloured in equal number and dimensions of blue and yellow vertical stripes (minimum of 4 stripes and maximum of 8 stripes).
- Fitted with an alternating blue and yellow flashing light with a nominal range of 4 nautical miles where the blue and yellow 1 second flashes are alternated with an interval of 0.5 seconds.

B1.0s + 0.5s + Y1.0s + 0.5s = 3.0s

- If multiple buoys are deployed then the lights will be synchronized.
- A racon Morse Code “D” and/or **AIS** transponder can be used.
- The top mark, if fitted, is a standing/upright yellow cross .

Lighthouse and lightships

Lighted navigational aids are essentially required to assist navigator in conducting the vessels during night hours. Therefore, the navigator must have knowledge of the light characteristics of the aids to navigation. Light house is one of the important lighted navigational aid, are placed in a height with powerful light to assist the navigator or wherever a danger requires a warning. Light houses are placed where they will be of most use, on prominent headlands, at entrances, on isolated dangers, or at other points where it is necessary that mariners by warned or guided. Their principal purpose is to support a light at a considerable height above the water. Visibility of a light increases with height of the beacon above the sea level. A lighthouse can also be used for keeping fog-signaling and radio beacon equipment. In earlier days lights were operated by keepers are now fully automatic with timers .

Solid colors, bands, stripes, and other color patterns are applied to lighthouses and light structures as an aid to identification. Minor structures sometimes are painted red or black, like channel buoys, to indicate the side of the channel on which they are located--red structures to the right, black to the left, returning seaward. The location of a light house whether in the water or on shore, the importance of the light, and the kind of soil upon which it is to be built and the prevalence of violent storms, have a direct bearing upon the type of structure erected and on the materials. Outward appearance of light house is important, because of the great difference in the distances from which their lights should be seen.

Lightships

Light ships are established to serve the same purpose as light house, being equipped with lights, fog signals and used only when it is impossible to construct a light house at the desired position. Light ships mark the entrances to harbours or estuaries, dangerous shoals lying in much frequented waters. Maintenance cost is very high for Light ships when compare to light house. Light ship is a specially designed vessel, anchored in a precisely determined position, equipped with a high intensity light of specified characteristics and usually with other supporting aids to navigation as well. Now these light ships an replaced by large navigational buoys, due to high maintenance cost.

Identification of lights

The navigator must be familiar with the lights and their characteristics printed in the chart to identify each light correctly. Each light is assigned with characteristics of colour and off-on periods for easy identification. In some instances, the shape and colour of the supporting structure will be of assistance in identification.

The vessel will be mislead when the navigator fail to identify lights correctly. The navigator should consult the charts and the Light Lists to learn the exact characteristics of the lights that are expected to appear before his vessel. The colour of the light and flashing characteristics in a full cycle should be carefully noted by the navigator. If colour, cycle, and number of flashes per cycle agree with the information given in the light list or chart, correct identification has been made. Light identification should be done carefully with lights of different intensities, alternate flashing with double colours and at the time of restricted visibility.

It is important to note that in Light Lists all bearings are stated in degrees true, reading clockwise from 000° at north; bearings relating to visibility of lights are given as observed from a a vessel; distances are in nautical miles unless otherwise stated; heights are referred to mean high water; depths are referred to the plane of reference on charts.

A light has distinctive characteristics which distinguish it from other lights or convey specific message. A light may show a distinctive sequence of light and dark intervals. Some navigational lights are fixed, meaning that they burn steadily without on-off characteristics. These characteristic features of a navigational light are the most valuable for identification purposes.

The following are the principal characteristics of lights used for navigational purposes,

Flashing: L ights are described as flashing – when the time on is less than they are off. A single flash showing at regular intervals, the duration of light always being less than the duration of darkness. When a light is flashing at the rate of not more than 30 per minute the light is called flashing light.

Quick Flashing : When a light flashing at the rate of not less than 60 flashes per minute, then the light is called Quick flashing light.

Interrupted Quick Flashing : This is the characteristics of a light with groups of six quick flashes repeated at intervals of ten seconds.

Occulting: A light totally eclipsed at regular intervals, the duration of light always being greater than the duration of darkness. Lights are termed as occulting, when they are on more than they are off (eclipsed).

If the times on and off are equal the light is designated as equal interval or isophase.

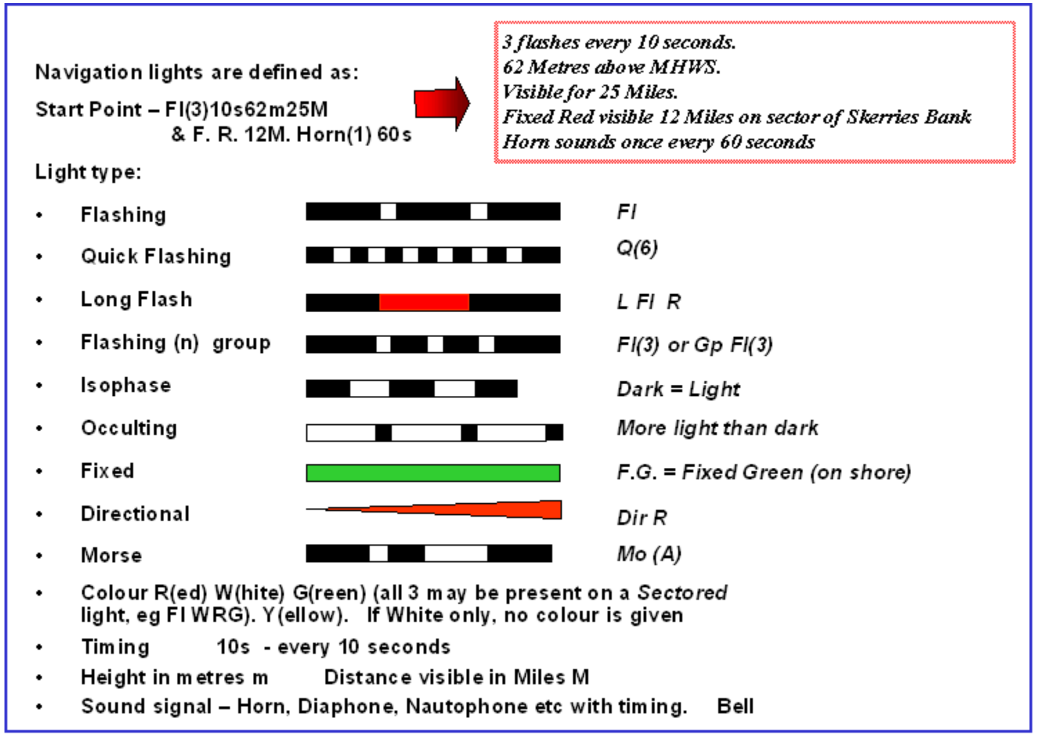
Group Flashing: Groups of two or more flashes showing at regular intervals.

Group Occulting: A light with a group of two or more eclipses at regular intervals.

Equal Interval (Isophase): A single flash with the duration of light equal to that of darkness.

Morse code: Light in which flashes of different durations are grouped to produce a Morse character or characters.

Alternating: Rhythmic lights which exhibit different colors during each sequence.



Visibility of Lights

The visibility of light is a specific distance, in nautical miles, a navigator is expected to see a lighthouse or beacon. The following are the different terms used to express the visibility of lights used for navigation purpose.

Horizon distance (Distance of visibility): T he distance, expressed in nautical miles from a position above the surface of the earth along the line of sight to the horizon.

Nominal range – is the maximum distance at which a light may be seen in clear weather (meteorological visibility).

Luminous range – is the maximum distance at which a light may be seen under the existing visibility conditions. This luminous range does not take into account of the elevation of the light, the observer's height of eye, the curvature of the earth, or interference from background lighting.

Geographic range – is the maximum distance at which a light may be seen under the existing visibility conditions, limited only by the curvature of the earth.

Computed range – is the geographic range plus the observer's distance to the horizon based on his height of eye. This is determined for a particular light, taking into account its elevation, nominal range, height of eye of the observer, and the curvature of the earth.

Light visibility may be restricted due to fog, rain, snow, smoke etc,.

Bobbing a light

When a light is first seen on the horizon, it will disappear if the observer tries to sight it from a point several feet or one deck, lower and reappear when he returns to original position. This is called bobbing a light and this will be helpful to estimate the distance of light.

DAY BEACONS

In shallow waters, day beacons are often used instead of buoys, because they are less expensive to maintain. Normally , day beacons are unlighted. These are single piles or multiple-pile structures(dolphins) driven into to bottom, on which are placed one or more signboards called "daymarks" which convey information through their color, shape, and lettering or numbers. Day beacons, like lighthouses and light structures, usually are colored to distinguish them from their surroundings and make them easy to identify Day marks normally have reflective material as part of their design. Two such day beacons are in line, used for taking transit bearing from a vessel poisoned in a particular place.

FOG SIGNALS

Fog signals are audible signals used to locate a navigational aid when it is not visible due to unfavourable conditions like fog, snow, rain, smoke etc,. Generally, they are established with another form of aid such as buoy, lighthouse, light ships, etc,. Navigator will identify the location of the navigational aid by assessing the place from where the sound originates.

The simple fog signals are bells, gongs or whistles on buoys.

Radio and radar beacons:

Like fog signals, radio beacons are also often co-located with other aids to navigation. At the conditions of restricted visibility and night hours these radio beacons are useful to take bearings from greater distances. Radar beacons, are also known as racons and ramarks.

Chapter 1: Fire Fighting Methods

Fire fighting

Fire on board is one of the major hazards in a vessel. A navigator should always be alert about the possibility of a fire. Prevention is better than fighting the fire. In the situation where there is fire accident the crew of the vessel must work together as a team to fight and survive. The navigator must know the type of fire and method of firefighting to select the right type of extinguisher and extinguishing agent. This chapter briefly gives an idea about the fire and fighting methods.

Chemistry of fire

In the oxidation process a substance combines with oxygen and form new chemical. Burning is the rapid oxidation of millions of vapour molecules.

The molecules oxidize by breaking apart into individual atoms and recombining with oxygen into new molecules.

During the process of oxidation, heat energy is released to the environment. As the combustion is rapid oxidation the fuel combines with oxygen at a very high rate. Energy is released in the form of heat and light. This is called as **fire**.

Fire triangle

Three things are essential to create a fire and continuous burning, they are,

1. Fuel (some inflammable material to vaporize and burn)

2. Heat (to raise the temperature of the fuel vapour to its ignition temperature)

3. Air (Oxygen to combine with fuel vapour)

This is called a Fire Triangle. There will be fire, if this triangle is complete. Fire will not be formed, if any one side of this triangle is removed.

This technique is followed in firefighting. Fire could be extinguished by breaking the fire triangle. If fuel, oxygen, or heat is removed, the fire will be off.

• Remove the heat that *cools down* fire.

• Remove the oxygen that *smooths* the fire.

• Remove the fuel that *starves* the fire.

Types of Fires

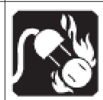
Fire could be classified in to four types

1. **Class "A"** fires (**Alpha**) involve **common** materials. Something made from wood, paper, cloth, rubber, and certain plastics. These objects produce an ash when burned.

2. Class "B" fires (**Bravo**) involve **flammable** or combustible liquids, flammable gases, grease, pretty much anything that is a petroleum product.

3. **Class"C"** fires (**Charlie**) involve **electrical** wire or instruments or equipment.

4. **Class"D"** fires (**Delta**) involve **combustible metals**, such as Magnesium, Titanium, and Sodium (**Mg, Ti, Na**)

CLASSES OF FIRES	TYPES OF FIRES	PICTURE SYMBOL
A	Wood, paper, cloth, trash & other ordinary materials.	
B	Gasoline, oil, paint and other flammable liquids.	
C	May be used on fires involving live electrical equipment without danger to the operator.	
D	Combustible metals and combustible metal alloys.	 D
K	Cooking media (Vegetable or Animal Oils and Fats)	

Extinguishing agents

An extinguishing agent is a substance that will remove any one side of fire triangle, causing the collapse of the triangle. Once the fire triangle is collapsed the fire will be under control and finally put off. Every extinguishing agent has specific action on fire, and one must be very careful while selecting the extinguishing agent for firefighting. The action of extinguishing agent could be classified in to,

1. **Cooling -** reduces the temperature of the fuel below its *ignition temperature*. This is a direct attack on the heat side of the fire triangle
2. **Smothering** -separates the fuel from the oxygen. This can be considered as an attack on the edge of the fire triangle where the fuel and oxygen sides meet.

3. **Oxygen dilution.**-reduces the amount of available oxygen below that needed to sustain combustion. This is an attack on the oxygen side of the triangle

Fire Extinguishing Agents

The following are the common fire extinguishing agents

1. LIQUIDS

A) **Water:** Water will act as **cooling** agent that absorbs the heat and cools the burning materials. Water is the commonly available extinguishing agents.

B**) Foam:** Foam is a mass of bubbles that cover the fire like blanket and extinguishes the fire by **smothering**. Mixing water and a foam-making agent (foam concentrate) produces bubbles

Chemical foam could be produced by mixing an alkali (usually **Sodium bicarbonate**) with an acid (usually **Aluminium sulphate**) in water.

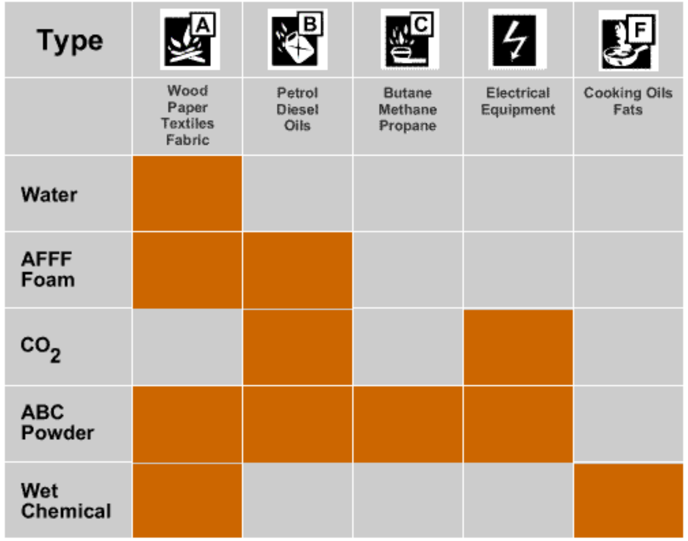
When chemical foam was first introduced, these substances were stored in separate containers. These two chemicals are packed separately in a sealed, airtight container. When these chemicals are intentionally mixed, they react and foam or froth of bubbles filled with **Carbon dioxide** gas are produced.

2. GASES

Carbon Dioxide (CO_2): Carbon dioxide extinguishes fire by **smothering**. It dilutes the air surrounding the fire until the oxygen content is too low to support combustion. For this reason, it is effective on **Class B** fires, where the main consideration is to keep the flammable vapours separated from oxygen in the air.

3. SOLID (DRY CHEMICAL)

Sodium bicarbonate is commonly used dry chemical extinguishing agent. It is widely used because it is the ***most economical extinguishing agent***. It is particularly effective on *animal fats and vegetable oils* because it chemically changes these substances into *non-flammable soaps*.



Fire Fighting Appliances

Various fire extinguishers exist for use on different fire sources. When dealing with a fire which is being fuelled by burning wood or paper, you may act very differently from the way you would on an electrical fire. Obviously water cannot be used on an electrical fire as water conducts electricity and could put you in grave danger if mixed with live electrics. This means you must choose a suitable fire extinguisher for the job in hand – even in the most perilous of emergency situations.

Every fire extinguisher has a colour-coded band that gives a quick reference as to what is in the container. It is essential that you learn these codes and the situations in which they are suitable to be used.

The principal precautions necessary to prevent fires on board fishing vessels:

- Awareness and training for fishermen about basics of fire and fire prevention.
- Keeping the fire extinguishers in suitable location.
- Maintenance of ***engine room*** and ***oil system*** free from leaks.
- Periodical checking of the ***bilge*** for oil and grease leaks.
- Clean the spilled fuel or oil immediately and properly dispose the wastes.
- Be alert for *suspicious odours and fumes*.
- Check for *abrasions, cracked wiring, or pinholes* in fuel and lube oil lines

Fire on board

When there is fire onboard:

- Shout FIRE, FIRE, FIRE.
- Give the fire alarm.
- Find out what type of fire it is.

- Alert the persons in the rest cabin and other places.
- Close all the ventilators and blowers to restrict the supply of air
- Start fighting with the fire, the movement it is detected.
- Use the appropriate fire extinguisher
- For electric fires, carefully analyse the situation, cut off the power supply and use DCP extinguisher.
- In all cases remove all inflammable materials from the surroundings and also cool the surroundings.
- Do not panic when you see fire, act wisely and do every action in a systematic way.
- The officer on duty should monitor every action in the ship without affecting the vessels stability.
- Fireman's outfit should be kept in all the vessels.

Fireman's Outfits

1. Fireproof asbestos suit.
2. Boots and gloves
3. A rigid helmet.
4. An electric safely lamp.
5. An axe
6. A smoke helmet or smoke mask

Chapter 2: Life saving appliances

Introduction

Every seagoing person is expected to know basic knowledge on life saving appliances and safety practices. Safety of life and properly at sea should be given top most priority while planning for any sea trip.

The minimum safety equipment to be carried on board a vessel is given in the regulations for each class of vessel including fishing vessel. Thorough knowledge on operation and maintenance of life saving appliances, firefighting appliances, tackling the emergency situations especially during bad weather, is also required for a successful mariner.

As far as fishing vessels are concerned emergencies may include fouling of gear and its effect on the stability of the boat, handling huge catches, man overboard, fire, engine breakdown, leak, grounding and distress and so on. Negligence or ignorance in this regard, will lead to great loss of life and property during emergency or distress at sea.

Rules and regulations are framed for each class of vessel regarding the type and number of life saving appliances is to be carried on board a vessel. Life saving appliances should be made of good quality material and workmanship to meet the requirement of the regulations and standards prescribed by the certifying authorities. Every person in the vessel shall be suitably trained on usage of life saving appliances.

Life-saving appliances

The following are the important points to be remembered while selecting the life saving appliances for any type of vessel,

1. The life saving appliances should be constructed with proper materials and workmanship
2. The material should withstand the **air** temperature range **-30°C to +65°C** during storage.
3. They should withstand the **seawater** temperature range **-1°C to +30°C**;
4. The appliance is made from *rot-proof, corrosion-resistant*, and not be affected by *seawater*.
5. The outer color of appliances should be bright (***red, orange, yellow***) and highly visible for easy detection during search.
6. ***Reflective*** material on the appliances will help the search team to locate the person who requires the assistance.
7. The information of *approval of the competent authority* including any *operational restrictions* needs to be printed clearly on the appliance.
8. The equipment or appliances shall be marked with *date of manufacture and expiry or replacement* of any part including batteries of the appliance or equipment.
9. Life jackets should be marked ***ADULT*** or ***CHILD*** to whom the particular size is meant for.
10. Step by step operation or usage instructions should be printed on the equipment or attach separately with water proof sheet.

Types of Life-saving appliances

As per the life saving appliance rule , fishing vessels are classified into two groups as:

Vessels less than 60 m in length & Vessels more than 60 m in length.

a) Vessels less than 60 m in length.

1. At least **four** approved **life buoys**. If the length is **less than 24 m**, at least **two** life buoys.
2. **One** approved **life jacket per person**.
3. Survival raft - **Emergency Position Indicating Radio Beacon (EPIRB)**.
4. Manually operated locating device **Search and Rescue Radar Transponder (SART**)

5. **Life rafts** of sufficient aggregate capacity to accommodate all persons the vessel is certified to carry.

b) Vessels more than 60 m in length

1. At least **six** approved **life buoys**.
2. **One** approved **life jacket per person**.
3. Survival raft **EPIRB**.
4. **SART**.
5. **Life rafts** of sufficient aggregate capacity to accommodate all persons the vessel is certified to carry.
6. Either a '**Rescue boat**' or a **Class 'C' boat** in lieu of life rafts (boat < 24 m)
   Need not carry EPIRB and SART if vessel < 12m and don't go beyond 12 nm.

1. Life raft

a) Constructed with suitable materials that capable for withstanding exposure of **30 days** in all sea conditions.

b) Withstand a drop test from a height of at least **18m**.

c) Have a **canopy** to protect the persons inside

d) Provide good insulation against heat and cold, provide insulation from heat and cold and provide sufficient head room.

e) It shall be capable of withstanding repeated jumps on to it from a height of at least **4.5 m above its floor** *both with and without the canopy erected*.

f) Have pleasing interior colour.

g) One or two entrances for entering the raft with prefect closing arrangements.

h) At least one viewing port in the canopy to view the outside .

i) Provision for collecting the rainwater from the canopy.

j) Fitted with lifeline in and around the raft.

k) Have a portable radio, EPIRB and SART in working condition the life raft.

Others

l) It shall be provided with an efficient painter of at least 15 meters.

m) Suitably constructed for towing at a speed of 3 knots in calm water with its full load of persons, equipment and with one sea-anchors.

n) Fitted with mooring rope of length equal to not less than 10 m plus the distance from the stored position to the waterline in the lightest seagoing condition or 15 m whichever is the greater.

o) Packed in a container that is constructed to withstand the hard conditions encountered at sea.

p) Marking required on life raft equipped in accordance with LSA code regulation

MARKINGS OF THE LIFE RAFT

- Manufacturer's name and address;
- Lifeboat model and serial number;
- Month and year of manufacture;
- Number of persons the lifeboat is approved to carry
- With approval information including the Administration which approved it, a
- Operational restrictions.

The following equipments shall also be provided in the life raft.

a. One buoyant rescue quoits with **30 metres buoyant line** for the purpose of assisting in the recovery of survivors.
b. One or more **safety knives** with **buoyant handle**.
c. Two **sponges** for mopping out residual water from the floor of the raft to collect condensation from the inside canopy.
d. **Two sea anchors** and **two paddles**.
e. **Three safety tin openers**, which may be in combination with the safety knife.
f. **One whistle** or any equivalent sound signalling apparatus to attract persons in water.
g. **Four rocket parachute flares** which emit a red flare at a height of not less than ***300 metres***, the burning period being not less than ***40 seconds*** with luminous intensity of ***30,000 candles***.
h. **Six red hand flares** to attract ships and air crafts, with burning period of not less than ***1 minute*** with luminous intensity of *15,000 candles*.
i. **Two orange** colour **smoke floats** with smoke emitting period not less than 3 minutes.
j. One waterpro**of electric torch** for **Morse signalling** (with a spare set of batteries and one spare bulb).
k. **One radar reflector- heliograph** ('***daylight signalling mirror***'- an apparatus that is used to send messages in ***Morse code*** by flashes of reflected sunlight
l. One copy of ***life saving signals***.
m. One set of approved **fishing tackle** which comprises line and six hooks.
n. Approved food rations totalling not less than **10,000 Kilo Joules** for each person.
o. **1.5 litres of fresh water** ***per person*** and one rust proof graduated drinking vessel.
p. **Six** doses of **anti sea-sickness medicine** and one sea-sickness bag for each person.
q. Approved instrucyion on how to survive and immediate action.
r. Thermal protective aids.

OTHERS:

s. Drinking water at the rate of ***0.5 litres per person*** that the life raft is permitted to carry.
t. Inflatable life rafts should also have a bellows or pump for topping up buoyancy chambers with a puncture repair unit
u. First aid outfit.
v. Non-toxic like carbon dioxide gas is filled in the cylinder for inflation.

OPERATION: To make the life raft inflate on emergency

a) Confirm that the operating cord is tied to the convenient and strong point of the ship.
b) Remove the tapes (lacing) and make the life raft overboard.
c) Pull out the rope/painter to its full length and give a sharp pull.
d) Now the life raft will inflate to the full shape, board without getting wet
e) Board the raft with specified number of persons (Do not overload the raft).
f) Cut the operating cord using the safety knife.
g) Using the paddles, move away from the sinking ship.

Servicing of life raft

- The life raft, should be surveyed every year by an authorized service station. Associated materials and hydrostatic release gear need to be inspected.
- Replace equipment if necessary.
- On inspection of life raft, the **Surveyor of Mercantile Marine Department** and will issue the service certificate which should be kept onboard.

Life boats

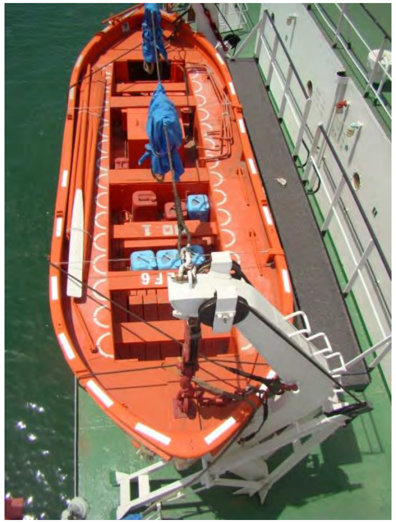
a. Constructed with non-combustible and strong material
b. Rigid strong enough to with stand to the weight under fully loaded condition.
c. Able to move with stability and safely with the speed of **5 knots.**
d. Constructed with enough free board
e. With inherent buoyancy or has some buoyant material filled inside the boat.
f. Have the maximum capacity of **150 persons**.
g. Capable of rapid boarding by all persons in **3 min**.
h. A **compression ignition engine** with either a manual or a power starting with in 2 min. at the temperature **-15°C**.
i. Sufficient fuel for running under fully loaded boat for at least 24 hrs at 6 knots speed.
j. Fitted with a device to slip the forward painter when under tension.
k. Has arrangements for erecting the **antennae** of **radar transponder beacon and portable radio apparatus.**
l. Have **electric flash light** at not less than **50 flashes/min**. is fitted on top of the lifeboat and burns for at least **12 h**.

Lifeboat markings

The number of persons for which the lifeboat is designed and approved shall be clearly marked on it with permanent characters.

The name of the ship or boat and port of registry of the ship to which the lifeboat belongs shall be marked on each side of the lifeboat's bow in block capitals of the Roman alphabet.

Name of the ship and number of the lifeboat on top of the lifeboat canopy so as to be visible from above.



Lifeboat outfits

1. Sufficient number buoyant ***oars*** to make headway in calm sea.
2. Two boat ***hooks***, for fending off when the boat is being lowered. These hooks should not be lashed.
3. A binnacle containing a ***magnetic compass*** which is luminous or provided with a suitable lighting arrangement. The compass may be fixed permanently in the totally covered boat.
4. Two ***painters*** of length at least **15 m** of double the height of the boat from light water line, whichever is greater.

5. A ***sea anchor*** of adequate size and strength fitted with a hawser and a tripping line.
6. Two hatches, one fore and one aft. They can be used for many purposes, such as hammer, or for cutting ropes etc. The blade has a canvas cover and the handle has a lanyard for lashing.
7. A buoyant bailer and two buckets.
8. A manual pump.
9. A box containing the following distress signals:
   a) Four **rocket parachute** flares.
   b) Six **red hand flares**. It gives a bright red flare for at least one minute.
   c) Two **Buoyant smoke** signals
10. Full rations for the total number of persons which the boat is certified to carry, on the following scales for each person:

a) A total of not less than **10,000 kJ** of food per person in air tight packages and stowed in a watertight container.

b) **3 litres** of fresh water per person, in water tight receptacles, of which **one litre per person** may be replaced by a desalting apparatus capable of producing one litre of fresh water per person in 2 days.
No food or water should be issued for the first 24 hrs.

11. A rust proof **dipper with lanyard**.

12. A rust proof **graduated drinking vessel**.

13. A **jack-knife** attached to the boat by a lanyard.

14. Three **tin openers**.

15. One set of **fishing tackle**.

16. One **first aid outfit** in a water proof case which can be tightly closed after use, for every 30 persons or part thereof.

17. Six doses of **anti-seasickness** medicine and one **vomiting bag** for each person.

18. One **Heliograph** for attaching attention of ships or aircraft in the **daytime**, with instructions for its use.

19. One water proof **signalling torch**, one spare battery and one spare bulb. Can be used for attracting attention of ships/aircraft at night.

20. One mouth-blown plastic **whistle** for attracting attention of the persons in the water when the lifeboat is searching for them at night.

21. An efficient **radar reflector**.

22. A **searchlight** capable of working for a total period of 6 hrs, out of which at least 3 hrs may be continuous.

23. A **survival manual**.

24. One copy of **Life Saving Signals** on a water proof card. These signals are shown at the end of this book.

25. Two **buoyant rescue quoits** with at least 30 m, of buoyant line each.

26. **Thermal protective aids** for 10 % of the capacity of boat or two which ever is the greater.

27. **Portable fire extinguishing** equipment for oil fires.

28. Sufficient tools for minor adjustments to the engine.

Note: All items of lifeboat equipment, except boat hooks, are either lashed or kept in lockers.

Lifebuoys

Every lifebuoy shall

a) Constructed of inherently buoyant material like thermocole or cork or any approved buoyant material.

b) Highly visible and bright colour (red/ orange/bright yellow).

c) Capable of supporting **14.5 kg of iron** in fresh water for a minimum period of 24 hours.

d) Weight minimum of **2.5 kg** but not exceeding **6 kg**.

e) Withstand a drop into the water from the height of **30 m**, without impairing either its operating capability or that of its attached components;

f) Fitted with **four grab lines** of **9.5mm** diameter secured equidistantly to form four loops.

g) Outer diameter not exceeding **800 mm** and inner diameter not less than **400 mm**.

h) Marked with name of ship and port of registry in English language.

i) Fitted with **self-igniting lights** with power backup for the use at least 2 hours (a fixed light or a light giving at least **50 flashes per minute**).

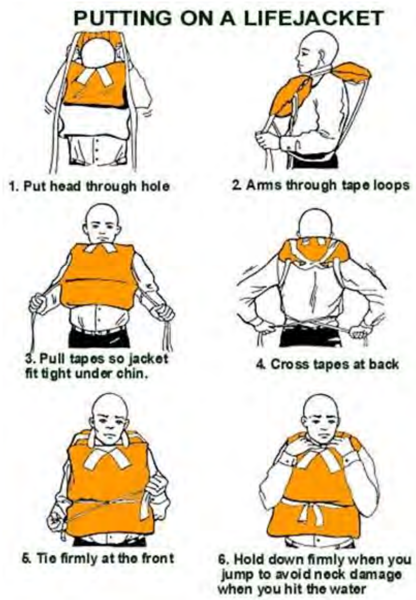
j) **Self activating** lifebuoy **smoke signals** should emit highly visible smoke (without flame or explosion) at uniform rate for at least 15 minutes.

Life jackets

Every life jacket shall

11. Constructed with any approved buoyant material (shall have buoyancy which is not reduced by more than 5% after 24h immersion in fresh water).
12. Correctly wear it within one minute by the person himself (At least 75% of persons, who are completely unfamiliar with the lifejacket, shall correctly wear it within a period of one minute without assistance, guidance or prior demonstration) .
13. Comfortable to wear
14. Highly visible and bright colour (**red/orange/bright yellow**).
15. Not sustain burning or continue melting after being totally enveloped in a fire for a period of 2 seconds.
16. Fitted with a ring or loop to facilitate rescue.
17. Allow the wearer to jump from a height of at least **4.5 m** into the water without injury and without dislodging or damaging the lifejacket.
18. Lift the mouth of an exhausted or unconscious person not less than **120 mm** clear of the water with the body inclined backwards at an angle of not less than **20°** from the vertical position
19. Turn the body of an unconscious person from any position to a comfortable floating position within five seconds.
20. Fitted with a plastic **whistle** firmly secured by a cord
21. Affixed with **retro reflective** tapes on both front and back side.
22. Two types of life jackets, one for adults, and the other for children and which are marked accordingly(**ADULT or CHILD**).
23. Allow the person wearing it to swim a short distance and to board a survival craft.
24. Fitted with a fixed or **flashing light** (at least 50 flashes per min) which burns for at least **8 hours**.(with a manually operated switch)
25. Wear the life jacket before you get into water, because it is impossible to wear a lifejacket while floating in water. Also the life jacket acts as insulator in preventing loss of body heat.

Method of jumping into water with life jacket



- Jump from a height of not more than 6 meters from water level.
- The tapes of the lifejackets must be tight with body.
- Before jumping, make sure that there are no obstructions in your way and that you are not jumping into a boat or on the canopy of a life raft.
- Then look parallel to the horizon, hold down your lifejacket by one hand and block off your nose and mouth by the other, keep your feet together, and jump-feet first.

Immersion Suit

Immersion suit covers the whole body except the face and can be worn in very shot time duration of 2 min. Non insulating immersion suits which are worn over warm clothing do not allow the body temperature to fall more than 2°C when a man is in water of 5°C for one hour. Immersion suits made of insulating material do not allow the body temperature to fail more than 2°C when a man is in water of 0°C to 2°C for 6 hours. Some immersion suits act as a lifejacket also but it is generally necessary to wear a lifejacket over the immersion suit. It is possible to jump, swim short distances, climb ladders and perform normal duties while wearing an immersion suit.

The immersion suit shall

a) be made of non flammable waterproof materials

b) not be sustain burning or continue melting after being totally enveloped in a fire for a period of 2 seconds

c) be suitable to cover the whole body except the face.

d) have the provision to minimize free air in the legs of the suit

e) be brightly coloured (red/yellow/orange)

f) be marked with instructions that it must be worn in conjunction with warm clothing

Thermal Protective Wear

A thermal protective wear is mainly used to cover a person to minimize both the convective and evaporative heat loss from his body. Like immersion suit thermal protective wear can be worn over the lifejacket and cover the whole body except the face. When a person with thermal protective wear finds difficulties in swimming it is possible him to remove in water with in 2 min. It provides thermal insulation to the body in temperatures ranging from -30°C to +20 °C.

Thermal protective wear shall

a) be constructed with waterproof materials, which reduces the risk of heat stress during rescue operations

b) be covers the whole body with the exception of the head

c) be unpacked and donned without assistance within 2 min

d) not burning or melting after being exposed to fire for a period of 2 seconds

e) facilitate lateral field of vision of at least 120°.

f) be marked with instructions

Portable Radio Apparatus

The Portable Radio Apparatus shall

a) be capable of floating in water and of being dropped into the sea from the bridge.

b) be fitted with an automatic keying device for sending distress and alarm signals.

c) Be provided with manual Morse key . It can receive signals also.

d) be provided with self supporting antenna.

e) Source of power is either a battery or a hand generator.

Radio telephone

Radio telephone shall

a) Be portable and battery operated sets working on VHF bands.

b) Have rechargeable battery, capable of working for 4 hrs.

Emergency Position Indicating Radio Beacon (EPIRB)

Every **EPIRB shall**

a) Be portable, light weight, watertight, buoyant, battery operated radio beacons

b) Be transmitting continuously or intermittently, a radio signal which can alert ships and aircraft via a polar satellite and enable them to locate a survival craft by homing in on the radio signal.

c) be thrown in water from a height of 20 m.

d) Have power back up for 48 hrs and require replacement every year.

e) Be automatic but can also be switched on and off manually.

f) Be provided with a light that indicates that signals are being sent from EPIRB.

Search and Radar Transponder (SART)

Every SART shall

a) Be buoyant, portable and manually operated

b) Be easily identified by the radar beams of ships and aircrafts.

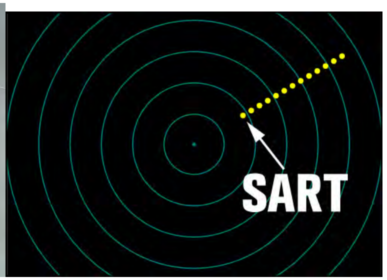
c) transmits a signal which causes a series of dots to appear on the screens of search radars on activation.

d) Be indicated by visual and / or audible means.

e) be switched on and off manually but may also be automatic.

f) be safely thrown in water from a height of 20 m.

g) have capacity to emit signals for 96 hours and thereafter to provide transponder response to searching radars for 8 hours continuously.



Rocket parachute flares

The rocket parachute shall

a) be packed in a water-resistant casing

b) have brief and clear instructions with illustrations for the use of the rocket parachute printed on its casing

c) have self ignition on activation

d) not cause discomfort or irritation to the person holding the casing when it is used.

e) reach an altitude of not less than 300 m, when fired vertically

f) eject a parachute flare, after reaching the designated height

g) burn with bright colour with luminous intensity of not less than 30,000 candles

h) have a burning period of not less than 40 s

i) have a rate of descent of not more than 5 m/s

Hand flares

The hand flare shall

a) be packed in a water-resistant casing

b) have brief instructions or diagrams clearly illustrating the use of the hand flare

c) have a self ignition

d) not cause discomfort to the person holding the casing

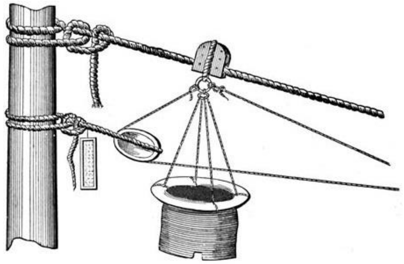
e) burn with a bright red colour

f) burn uniformly with an average luminous intensity of not less than 15,000 candles

g) have a burning period of not less than 1 min

h) continue to burn after having been immersed for a period of 10s under 100 mm of water.

The Breeches' buoy



Breeches' buoy is used to transfer of persons from a disabled ship to either rescue ship or to shore. It consists of a Life buoy which has a flat piece of good quality canvas sewn to it to act as the saddle. The life buoy is hung from a rope to be used for heaving with at least 4 ropes at each diagonal end of the life buoy. The initial line may be sent from the rescue ship to the disabled ship by using a line throwing apparatus. Once the line has been received the rescue ship would attach a block through which a strong rope (the Whip rope) has been reeved in (this rope presently has no use and the ropes would be very slack and no attempt must be to haul on this rope (pair since it is reeved through the block).

The rocket line is to be hauled away until this block is on board, when the rocket line is to be discarded. The block would now be attached to a mast. Once the block is fast, the rescue ship would attach a still stronger rope (small diameter hawser lay rope) to the rope passing through the block and once this is brought on board the disabled ship it is made fast to the mast above the whip rope block. Once the hawser is fast the rescue ship would have it tight and make fast. Adjusting as required if the ships fail to maintain their distance. The breeches buoy is now rove in through the hawser and a steadying line is attached to prevent the swing of the buoy. The travelling rope is now pulled from the rescue ship, which enables the buoy to move to the disabled ship. Persons may now embark on the buoy and again be pulled to the rescue ship.

BUOYANT SMOKE SIGNALS

The buoyant smoke signal shall

a) be packed in a water-resistant casing

b) not explode when used in accordance with the manufacturer's operating instructions

c) have brief instructions or diagrams clearly illustrating the use of the buoyant smoke signal printed on its casing.

d) emit smoke of a highly visible color at a uniform rate for a period of not less than 3 min when floating in calm water

e) not emit any flame during the entire smoke emission time

f) not be swamped in a seaway

g) continue to emit smoke when submerged in water for a period of 10 s under 100 mm of water.

Line throwing appliance

Line-throwing appliance is lifesaving appliance for use in any emergency situations where a line is required between two vessels or between vessel and shore for transfer of persons or goods. There are many types of line throwing appliances are available in the market, but all of them have a projectile attached to one end of a long thin line which can run out freely. Different techniques are used to propel the projectile. Rockets are commonly used to propel the projectile.

Every line-throwing appliance shall

a) be capable of throwing a line with reasonable accuracy

b) include not less than four projectiles in a pack, each capable of carrying the line at least 230 m in calm weather

c) include not less than four lines each having a breaking strength of not less than 2 kN

d) have brief and simple instructions with suitable diagrams clearly illustrating the use of the line-throwing appliance

e) be contained in a water resistant casing for pistol-fired rocket

Chapter 3: Manning Regulations for fishing vessels

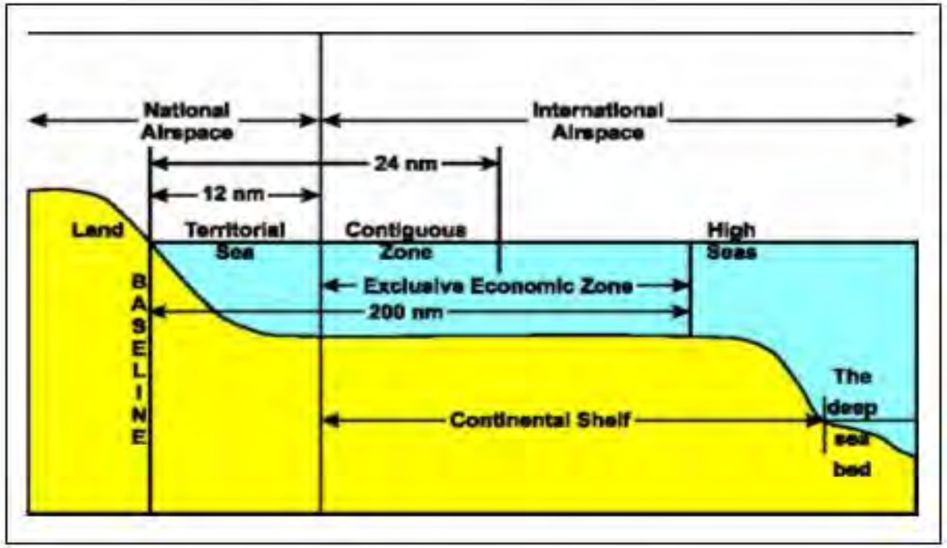


Figure 1 Maritime Zones
(Schofield, 2003: 18)

As per **Merchant Shipping Act (Amendment) 1987** the statutory requirements of manpower for the fishing fleet of our country is as follows,

Every Indian fishing vessel when going to sea from any part or place in India shall be provided,

(a) If the vessel is of 24m or more in length and is operating beyond contiguous zone (24 nm from the shore), with certificated Skipper Gr. I and a certificated Mate of fishing vessel.

(b) If the vessel is of 24m or more in length and is operating beyond contiguous zone, with certificated Skipper Gr. II and a certificated Mate of a fishing vessel.

(c) If the vessel is of less than 24 m in length and is operating beyond the contiguous zone with a certificated Skipper Gr. II and a certificated Mate of a fishing vessel.

(d) If the vessel is of less than 24 m in length and is operating within the contiguous zone, with a certificated Skipper Gr. II.

(e) If the vessel has a propulsion power of 750KW or more with at least one engineer of fishing vessel, who shall be designated as Chief Engineer and one Engine Driver fishing vessel.

(f) If the vessel has a propulsion power of 350 KW or more but less than 750KW with at least one Engineer of a fishing vessel who shall be designated as Chief Engineer.

(g) If the vessel has propulsion power of less than 350KW with at least one Engine Driver of fishing vessel who shall be designated as Engineer-in-charge.

Subsequently, some additional hands indicated below have been specified for fishing vessel manning vide an executive order No. MSL-1(2)/95-1 dated 17th September, 2002 of Directorate General of Shipping, Mumbai taking into consideration the necessity of support of staff on fishing vessels:

1) Fishing vessels having propulsion power of 750KW and above;

Engineer of fishing vessel -1 no

Engine Driver of fishing vessel - 1no

Rating/Engine hands - 3 Nos.

2) Fishing vessels having a propulsion power of 350 KW to 750 KW; Engineer of fishing vessel - 1no

Rating/engine hands - 3 Nos.

3) Fishing vessels having propulsion power of less than 350 KW;

Fishing vessel Engine Driver - 1No

Rating/Engine hand - 1 No

ELECTRONIC NAVIGATION

Chapter 1: Sonar and Net sonde

Introduction

SONAR (an acronym for **S**ound **NA**vigation **and R**anging) is an acoustic equipment that works with the principle of underwater sound propagation like echosounder. It is useful to navigate the vessel safely and to find the fish shoal in the distance from a vessel and can measure the echo characteristics of "targets" in the water.

Originally it was called as **"ASDIC"** which stands for "**Allied Submarine Detection Investigation Committee**" developed for the naval welfare as a device to detect sub marine during the World War I. In World War II, the Americans used the term **SONAR** for their systems. Later, this is used for finding fishes and become indispensable equipment for the successful and profitable fishing operation.

Principle is similar to **echo sounder**. In case of echo sounder, the *ultrasonic* sound waves are transmitted *vertically downward*, but in SONAR, the sound beam can be directed to any angle by turning the transducer to any bearing around the vessel to *360º*.

Working Principle of SONAR

Basically, SONAR operates in the same way as echosounder, and has the same four main components. In case of echo sounder, the *ultrasonic* sound waves are transmitted *vertically downward*, but in SONAR, the transmission of sound wave is ***horizontal*** with ***long range***.

Main Components of SONAR

SONAR has the four basic components:

1) Transmitter

2) Transducer

3) Recorder

4) Display

Transmitter

- Transmitter is in the case of echo sounder, the transmitter generates pulses of electrical energy and pass on to the transducer.
- The pulses of SONAR are meant for long ranges, there are differences in *frequency, power* and *pulse length*.
- For *longer range use **lower frequencies*** are preferred because they travel farther in water.
- Common sonar frequency range from **20-40KHz**.
- The **power output** is increased up to **10 KW** as compared with about 1KW for an average echosounder.
- To get such high power into the water the **pulse lengths** are increased up to **40 milli seconds**.

Transducer

- The function of transducer is same as in the case of echosounder.
- SONAR is able to train (rotate) the transducer through **360º** and also be **tiltable**, usually from about **+5°(up)** slightly towards the sea surface and to **-90°(down)** vertical down to the sea bed.
- In order to achieve this, the transducer is mounted in **gimbals** and in order to *avoid the turbulent layer and aerated water along the hull of the ship*, it is *lowered to about **1 m below the ship's bottom** when in operation*.
- The transducer assembly must be able to withstand mechanical stress when the vessel is moving and must be ***retractable*** when not in use, when docking, or in very shallow water; also to avoid fouling fishing gear, such as purse seine.
- Built-in safety feature in larger transducers retract it automatically when switched off.
- The control for the transducer is mounted, with the recorder, in the wheelhouse.

Receiver

- The SONAR receiver is similar in operation to that of echosounder.
- The very weak signals that are returned from fish shoal or any target to the transducer are amplified to a sufficient magnitude and sent to the display unit.

Recorder

- Since it is horizontal distance of an object from the vessel, the display of target on the sonar gram (paper record of echos from sonar) may not give great details.
- A display which is better able to indicate distance and direction is the **Plan Position Indication** (**PPI**) on a ***CRT***, which is similar to a radar display.
- The ship is the centre of the scope and the sonar beam can be seen travelling away from the ship on the bearing selected. If a target is detected the echo is shown on the screen, giving an indication of its range and bearing.
- The approximate depth of the target can be calculated from the distance and the angle of tilt.
- The audible indication of the echoes by loudspeaker is essential for the target identification. An experienced operator can distinguish between different types of echoes better by the sound than from a paper record or CRT display.

Fishing with SONAR

- The echosounder indicates the bottom of the sea and fish under the vessel, the sonar can search a whole area, horizontally, in all directions. Further, it can be adjusted to any angle by tilting the transducer, or used vertically, for which purpose the transducer is moved into the same position as that of an echosounder.
- The sonar has mostly been used for pelagic fishing methods such as purse seining and mid water trawling. It is also quite useful for assessing bottom conditions and configurations, which are of interest for bottom trawling and other bottom fishing techniques.

<u>NETSONDE</u>

- Net sonde is a special acoustic instrument which collects the operational information of trawl net. It has the same working principle of echosounder, but for the position of the transducer. The transducer of the net sonde is fixed in the head rope of the trawl net.

- It monitors the operation of trawl net and its catch and transmits it for display in the wheel house during trawling. Net-sonde is also called as Trawl eye or Net sounder or Trawl Monitoring System.
- Net sonde was initially developed for midwater trawling. Later it was found that it can also be most useful in bottom trawling for measuring the opening height of the trawl mouth and for ensuring continuous bottom contact.
- In addition to this continuous control of gear performance the netsonde used in bottom trawling also provides a much better estimate of catching efficiency and amount of catch by showing the fish in and above the net opening.
- Net sonde equipment requires a direct connection between fishing gear and wheel house a vessel which can be either by cable or by a wireless link.
- For observing the trawl opening and fish entering, only one transducer is mounted on the headline of the trawl, usually sounding straight downwards.
- When midwater trawling over very deep water with the bottom outside the sounding range the transducer may be attached to the foot rope sounding straight up to the surface.
- In the operation of aimed pelagic or mid water trawl it is essential to identify the position of the trawl net relative to the fish shoal. Net sonde also obtain information about the fish distribution and their reaction in front of and around the trawl, as well as providing more complete data on the gear itself. Using the display the skipper can observe whether a fish school being approached is higher or lower than the trawl opening or to the right or left, and an adjustment of trawl depth and course may be made accordingly.

Chapter 2: RADAR

RADAR (Radio Detecting And Ranging)

RADAR is an important navigational aid, working with radio waves. The word RADAR was coined in **1941** and stand for an acronym of **RA**dio **D**etection **A**nd **R**anging. The radar is useful in guiding the navigator especially when sailing in coastal waters and always when visibility is poor.

Radar is used to identify any objects including ships and buoys and to measure the range, altitude, direction or speed of both moving and fixed objects. Radar can also be used in clear visibility for navigation or collision avoidance purposes by detecting the objects or targets above the water level.

The range of visibility is optional medium range radar could be useful up to 100 nautical miles. Sonar is known for its usage to identify the underwater objects with sound waves, but radar is using radio waves to find out things above the water level. It is also called as **radio location.**

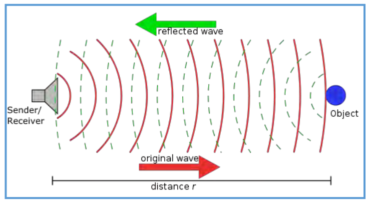
The frequency of electromagnetic energy used for radar is unaffected by darkness and also penetrates fog and clouds. This permits radar systems to determine the position of airplanes, ships, or other obstacles that are invisible to the naked eye because of distance, darkness, or weather. Modern radar can extract widely more information from a target's echo signal than its range. But the calculating of the range by measuring the delay time is one of its most important functions.

The waves applied in Radar are high frequency radio waves. The frequency ranges between 100MKz with a wave length of 3meters to 60,000MHz, with a wave length of 5mm. Most radar waves are within a band of radio waves known as microwaves. Microwaves tend to pierce the ionosphere, the electrified zone of the upper atmosphere that reflects radio broadcasting waves. Hence conventional radar can detect only those objects that are in a direct line of sight from the transmitting antenna.

The first practical radar was invented by the British physicist Robert Watson Wolt in 1935, but then many features were added to make the radar perfect for the use in the Second World War; it has been in use since 1941. During 1940s different types of radar sets were developed in the USA, Russia, Germany, France and Japan.

Working Principle of RADAR

Basically radar works on the same principle as an echo sounder but use radio waves instead of sound waves. Radar sends radio waves with the help of directional antenna to particular direction. The radio wave travels with the speed of light that is $3x10^8$ m/s, hit an object if any, on the way of radio wave and bounce back as echo. Since the waves travel at a constant speed ($3x10^8$ m/s), the distance of an object can be calculated by noting the time interval between transmission of a wave and reception of an echo.



If the travel time of radio wave from antenna to object and back to the antenna as echo is ' t', then the distance(Range-R) between the antenna fitted vessel and the target object may be determined by the simple formula:

R = c t/2

Where c = 3 x 10^8 m/s, the speed of light or radio wave.

The value needs to be taken as 50% because the radio wave pulse travels twice the time of actual required.

Radar signals can be displayed on the Plan Position Indicator (PPI) with rotating vector indicates the pointing direction of the antenna and hence the bearing of targets.

Components of RADAR

Modulator

Modulator is the heart of the system. It produces electric pulses that trigger the transmitter to send the specified number of radio signals. Also it controls all the time related functions in radar.

Transmitter.

The transmitter generates powerful pulses of radio frequency (RF) in the form of short pulses with definite intervals. The radio waves are usually sent in short pulses, with each pulse duration fraction of a microsecond. (A microsecond 1/10,00,000) Enough time intervals will be given for the echoes to return back to the antenna. Normally, 50 pulses per second are sent from the transmitter.

Duplexer

The duplexer is an electronic switch that alternately connects the transmitter and receiver to the antenna, which facilitate to transmit the pulse and to receive the echo.

Antenna (Scanner) :

The antenna also known as scanner takes the radio frequency energy from the transmitter and send to air in a well defined directional beam. The antenna system also receives any returning echoes and passes them to the receiver. The antenna is capable of rotating 360^{o} (always rotate in clockwise) with a speed of 15-25 rpm.

Receiver

The receiver receives the weak echo signals from antenna, amplifies and produces them as video pulses to be applied to the indicator. The receiver is sensitive to the range of frequencies being transmitted and provides amplification of the returned signal.

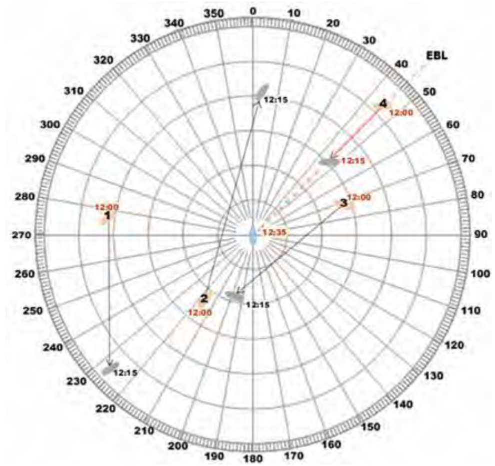
Indicator (Display unit)

The indicator or display unit produces a visual output to the observer in easily understandable picture of the relative position of radar targets from the scope's centre. Radar determines distance of an object by calculating the time required for a radio signal to travel from a transmitter to an object and return back as echo. The radar can also determine bearing of an object. The common display used in radar is Plan Position Indicator (PPI). The information of return echo is converted into brightness and then displayed in the same relative direction as the antenna orientation.

The advantages of radar are :

1. It is used at night hours and low visibility time.
2. It gives the accurate picture about the objects available around the vessel.
3. It is also useful to trace heavy storms and low pressures areas
4. It is possible to take bearing of any object around a vessel.
5. The distance between the vessel and target can be measured
6. The direction of movement of vessel can be found out

Ship-borne RADAR



"Radar has proved to be an extremely valuable aid for position fixing and collision avoidance, but using it is not as easy as may appear at first sight. This is proved by the many stranding and collisions which have occurred involving radar equipped vessels.

Radar Bearings

"Radar bearings are subject to many possible errors and when trawling at long ranges from the coast, it does not take a large error to make the difference between making a good catch and losing the nets. Frequent comparisons should be made between visual and radar bearings of distant objects, and to see that objects right ahead of the vessel do appear on the heading marker.

Radar Ranges

"Fixing the vessel's position by means of radar ranges will be more reliable than using bearings, but the objects used must be positively identified. Of particular importance when fishing outside territorial waters, is not to mistake a line of hills inshore for the coastline.

Target Detection

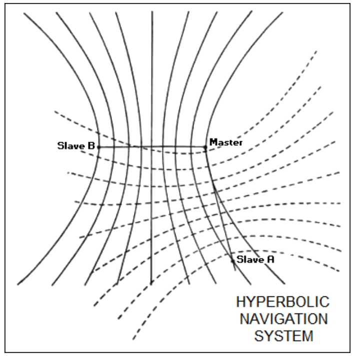
"The probability of a target returning radar echoes will depend upon its size, composition, aspect or shape and background.

Size

"The strength of the echo returned will depend upon the reflecting area of the target. "The maximum detection range will depend upon the height of the scanner and the height of the target. Under normal atmospheric conditions this will be in nautical miles.

Chapter 3: Radio Navigation - Decca, LORAN, and omega Navigations

Decca Navigator



Decca is a hyperbolic radio navigation system used for fixing a ship's position with great accuracy. This system was established in UK during World War II and later used in many areas around the world. The Decca system work with minimum three shore based transmitter stations called 'Chains' operating within the frequency range of 70-130 kHz . Each chain comprised of one Master station and two or three Slave stations (identified in terms of Red, Green and Purple colours), usually located 80 to 110 Nm from the Master station.

The Slaves are positioned at the vertices of an equilateral triangle with the Master at the centre. Each station transmitted a continuous radio wave signal, and each station signal was identified with the phase difference from the Master and other Slaves. These phase difference formed a set of hyperbolic lines of position called a 'pattern'. The three Slaves were identified by different colours namely, Red, Green and Purple. The hyperbola patterns were drawn on nautical charts as a set of lines with the designated colour. Decca receivers fixed onboard a vessel identified the hyperbola by phase difference and intersection of the hyperbola from different patterns. The accuracy of Decca system ranged from 50 meters during daytime to 200 meters at night.

Working principle of Decca Navigator

The radio waves are used to determine vessel's position by either radio direction finding systems or hyperbolic systems such as Decca, Omega and Loran. Decca, Omega and Loran are called Hyperbolic Navigation Systems because a hyperbola is the locus of all points in a flat plane. Propagation of radio waves is dependent upon factors such as frequency of the transmission, time of the day, distance between transmitter and receiver etc,. If simultaneous transmissions are made from master and slave stations, then the signals will arrive at the same time on the Centreline, but at any point of the hyperbole with a time difference. If the time difference is obtained it can be plotted as a LOP in the Decca chart of that particular area (chain of Decca system will be overprinted on a navigation chart, called a lattice).

The Decca Chain

A Decca chain consists a master station controlling the phase of three slaves, which are positioned about 120 degrees apart, at a radius of 60 to 100 miles from the master. This network will cover the maximum possible area.

- **Master** Station normally transmitting signal within the range of 84 - 86 kHz,
- **Red** Slave Station transmitting a " **8f** " signal in the 112 - 115 kHz ,
- **Green** Slave transmitting a " **9f** " signal in the 126 - 129 kHz ,
- **Purple** Slave transmitting a "**5f** " signal in the 70 - 72 kHz .

Decometers

The phase differences between the signals of two stations are displayed on phase meters called '**decometers**'. The readings of the decometers are plotted onto Decca lattice charts, on which the lines of position are numbered in the same units as those shown on the decometers.

The decometer gives the readings continuously depending on the coverage. Two readings of decameters are taken simultaneously to fix the vessel's position.

In hyperbolic systems the receiver (ship) has only to measure the time difference and does not have to be synchronized with the transmitters. The transmitters of the master and slaves have however to be synchronized. The decometer placed on board a vessel indicates the phase difference in the radio signal as the vessel moves. The decometer gives 2 Lines of Positions (LOP) from the signals received from the master and slave stations. These two LOPs are used for fixing the vessels position.

Decca system is used only for coastal navigation including fishing vessels. The main application of Decca system is that fixing the position of vessels.

LORAN (Long Range Navigation)

LORAN is a hyperbolic terrestrial radio navigation system developed by US Army in 1940's. LORAN is an acronym for ***Lo***ng ***Ra***nge ***N***avigation. The Loran position-fixing system was developed during World War II by the U.S. to aid marine navigation with the operating frequency 2 MHz, this system was known as Loran A. Then they developed Loran B system, which was a high-accuracy version of Loran A, was not implemented because propagation disturbances rendered cycle selection unreliable. The Loran C system is an improved system developed from Loran A to provide greater range and for accurate navigation. After the termination of LORAN A in 1980, Loran C quickly deployed. The current version of LORAN is LORAN-C. LORAN system is a net work of land based radio transmitters (one master and 2,3 or 4 slaves or secondary stations called a chain). The LORAN system works with low or very low frequency bands raning between 90kHz - 110 kHz with the transmitting power of 400 - 1600 kilowatts. The operation range of LORAN system is more than 1000 nautical miles (1800 km). Many nations use this system, including the United States , Japan , and several European countries. Russia uses a nearly identical system to LORAN in the same frequency range, called CHAYKA .In India, Loran-c is functional at two places viz. Diamond Harbor, Calcutta (GRI 5543) and Dhrangadhra, Bombay (GRI 6042).

LORAN-Working Principles

LORAN is working based on the principle of the time difference between the receipt of radio signals from two radio transmitters positions at different places. The theory is to calculate the time between reception of the signals from the MASTER and SLAVE stations, which are emitted at different frequencies. The constant time difference between the radio signals from the two different stations can be represented by a hyperbolic line of position (LOP). The position of the receiver (vessel) can be determined by identifying the positions of the two synchronized stations. The vessel's position is found as the intersection of the line of two LORAN stations.

Even though LORAN-C is the latest system, which was discontinued due to costlier in operation. U.S. Coast Guard terminated the transmission of all U.S. LORAN-C signals on February 8, 2010

Parts of LORAN unit

A LORAN Unit consists of the following parts:-

1. **Signal processor** - receives the signals, process and calculate the difference between the time of arrival of each secondary station pulse group and the master station pulse group. The time difference is depend on the location of the receiver on the vessel in relation to the three or more transmitters. Each time difference value is measured to a precision of about 0.1 microseconds.

2. **Navigation computer** - converts time difference values to location corresponding latitude and longitude.

3. **Control and display** –displays the readings

LORAN-C is applied in the following fields,

1. As an electronic aid to marine navigation (Position in terms of Latitude-Longitude, Bearing and distance, Ground speed and Course deviation Indicator)

2. Used in airborne and land position fixing

3. Used in determination of atmospheric winds. For this application, meteorological probes, in the form of balloon-borne radiosondes, retransmit narrow-band Loran C signals to be processed at the tracking facility.

4. Used for radiolocation, automatic vehicle monitoring in both rural and urban environments on land.

Chapter 4: GPS - Global Positioning System

Global Positioning System

Navigation is the act of fixing the position and determining the course of movement of a vessel. Since prehistoric times, the sailors have been using various traditional techniques to fix their position at sea. Moreover, the ancient mariners followed the near coast navigation. When navigators first sailed into the open ocean, they discovered they could chart their course by following the stars. In the early 20th century several radio wave -based navigation systems and equipments were developed, which were used in the World War II. The problem with the radio wave based navigation systems was that they were restricted to use only in certain parts of the world. High-frequency radio waves can provide accurate position location but can only be picked up in a small, localized area. Lower frequency radio waves can cover a larger area, but cannot provide accurate position location.

Then it was decided to have one method to provide coverage for the entire world. A transmitter high above the Earth sending a high-frequency radio wave can cover a large area. This is one of the main principles behind the GPS system. The first GPS satellite was launched in 1978. The first 10 satellites were developmental satellites, called Block I. From 1989 to 1993, 23 production satellites, called Block II, were launched. The launch of the 24th satellite in 1994 completed the system. Initially, they were defence devices developed by the US government. It was then opened up for civilian use since 1993. GPS, the Global Positioning System, is the only system today able to show you your exact position on Earth at anytime, anywhere, and in any weather. In the late twentieth century, the global positioning system (GPS) largely replaced the Loran. GPS uses the same principle of time difference from separate signals as Loran, but the signals come from satellites. GPS is an acronym stands for Global positioning system. These satellites are maintained and operated by U.S. Dept of Defence. Although originally conceived for military needs, GPS has a broad array of civilian applications including surveying vehicle tracking, land, aviation and marine navigation.

Working Principles

The Department of Defence, USA, launched 24 satellites to go around the earth exclusively for their military purpose. Satellites have known orbits in term of position with regard to earth and they are continuously emitting radio signals. At a time, we can get signal from at least 4 satellites at any position on the earth. The micro computer available in GPS receiver makes the computation and gives the position in terms of latitude and longitude.

The GPS system consists of the following three segments,

1. Space segment

The original space segment consists of 24 satellites (21 operational satellites with 3 active spares) at the orbit height of around 11,000 nautical miles (20,200 km) . The satellites complete an orbit approximately once every 12 hours. S o there will be between five and eight satellites in view at any time, from any point on the Earth's surface.

Each satellite is equipped with an atomic clock (made of Cesium and Rubidium), which accurately keeps time to within three nanoseconds (that's 0.000000003, or three-billionths of a second) . The signal travels from the satellite to the ground at the speed of light. The difference between the time when the signal is received and the time when it was sent, multiplied by the speed of light, enables the receiver to calculate the distance to the satellite. To calculate its precise latitude, longitude, and altitude, the receiver measures the distance to four different satellites. In addition to the American GPS satellites, Russia established GLONASS system and GALLILEO system launched by European countries.

The GPS control segment consists of several ground stations located around the world with a master control station at Schriever Air Force Base in Colorado, USA. In addition, five unstaffed monitor stations are established at Hawaii and Kwajalein in the Pacific Ocean; Diego Garcia in the Indian Ocean; Ascension Island in the Atlantic Ocean; and Colorado Springs, Colorado .

3. Receiving segment or user segment

The receiver of the GPS system is the user segment. The receivers are designed to fulfil the requirement of the different users. Now a days, the usage of GPS is in almost all the fields including fisheries. It receives the signal from the satellite, process it and display the required information including position in terms of latitude and longitude and speed of the vessel or aircraft that carries the receiver.

Method of operation

Satellites moving around the earth have known orbits in terms of time and position with respect to earth. The GPS detects the presence of the satellites which are acting as moving reference points and calculates the position of the boat from the parameters namely the speed of the satellite, its altitude, azimuth angle and other data based on the relative movement of the satellite with reference to earth. The micro computer in the GPS makes the computation instantly and gives the position in terms of lat. and long. Other facilities of the equipment such as speed of the vessel, navigational route, destination point etc are also computed from the basic data. GPS provides highly precise, continuous worldwide, weather proof, position plus time and velocity information to GPS receivers – equipped vehicles vessels and aircraft GPS is the most accurate technology available for navigation today. Currently there is 24hours, worldwide two dimensional GPS coverage available which makes GPS fully functional for marine applications. The Global Positioning System (GPS) is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations.

The ground control segment consists of a master control centre and a number of widely separated monitoring stations. The ground control network tracks the satellites, precisely determines their orbits, and periodically uploads almanac ephemeris, and other system data to all satellites for retransmission to the user segment. The user segment is the collection of all GPS user receivers and their support equipment. More simply, the GPS Receiver's position is determined by the geometric intersection of several simultaneously observed ranges (satellite to receiver distances) from satellites with known co-ordinates in space. The receiver measures the transmission time required for a satellite signal to reach the receiver.

The receiver processes satellite orbit data to determine the user's three-dimensional position. A minimum of four observations are required to mathematically solve for four unknown receiver parameters (i.e., latitude, longitude, altitude, and clock offset).

Application of GPS

By using the GPS, one can identify his geographic position (longitude and latitude), altitude, velocity and direction of travel. GPS has various applications on land, at sea and in the air.

GPS are used in the following fields

- Air craft navigation
- Marine navigation and fishing
- Car navigation
- Surveying
- Recreation e.g. hiking
- Tracking
- Emergency response e.g. ambulance and fire
- Mapping
- Military
- Town planning and Land management

Use of GPS in marine navigation and fishing

Fishing vessels require electronic equipments for safe navigation especially to know their position at sea and to go through planned routes and also to locate Potential Fishing Zone (PFZ).The details of places where the fishes are expected to aggregate more (PFZ) could be obtained from remote sensing agencies. . In India, Remote sensing agency stationed at Hyderabad gives information about PFZ (Potential Fishing Zone) for the benefit of fishermen. Fishermen require GPS to indentify the PFZ. GPS is recently developed equipment which is easy to operate, very convenient, very accurate and reliable. The unit is very simple; no license is required to operate. Accuracy of the instrument is ± 30m. The system available as a small unit can be installed even in small fishing vessels conveniently to indicate the latitude and longitude. The fishermen operating country crafts such as catamarans can have the handheld model of GPS.

Modern GPS are now available with a several new facilities – the operating can decide the destination point of points and the instrument will give directions for shortest route to those points as well as returning back. This ensures safe voyage without wandering in the sea. The instrument gives alarm when the vessel deviates away from the desired route. It also gives from the desired route. It also gives the speed of the vessel and also total distance travelled at different times.

In addition to the position and velocity of fishing vessels, a modern GPS will be giving the following information

- A course to steer to the waypoint (continually updated).
- The distance to the waypoint (continually updated).
- Once underway your speed (continually updated).
- The time it will take to get to the waypoint at your current speed (continually updated).
- Turn, Steer or Off-Course Error -- the GPS should tell you when you are off course and what direction to turn to get back on course.

- Various alarms should be available such as:
    - An arrival alarm which sounds when approaching a waypoint.
    - A proximity alarm which sounds when you come within a preset distance of any of several waypoints, regardless of whether they are your destination.
    - An anchor alarm which sounds when you travel more than a preset distance from a waypoint.
    - An off-course alarm which sounds whenever you are exceeding a preset distance from your intended course.

The readings of GPS could be used in combination with an autopilot, radar, or plotter for further advanced automatic and safe navigation.

Other features

- No license required
- 12/24V DC supply is required
- Very simple operation
- No wear and tear – less service
- Antenna is required for permanent fixing GPS
- Accuracy is – 20m to 50m
- Man over board alarm Man over board position is a facility available in GPS. It is to locate the place of fall of man.

During travel of the vessel if any mishap happens, for example a crew member falls in the sea the position can be immediately marked in the GPS memory. After that the equipment will show the present position of the vessel and also the position of fall of the crew member marked earlier. This will help easy reserving.

- Anchors watch alarm to locate the position of anchorage.

When the GPS is put in this mode of operation during anchorage it will give alarm of the vessel is drifted from the anchored position beyond a present limit.

Differential Global Positioning System (DGPS)

Differential Global Positioning System (DGPS) is an enhancement to Global Positioning System that uses a network of fixed, ground-based reference stations to broadcast the difference between the positions indicated by the satellite systems and the known fixed positions. These stations broadcast the difference between the measured satellite pseudoranges and actual (internally computed) pseudo ranges, and receiver stations may correct their pseudoranges by the same amount. The correction signal is typically broadcast over UHF radio modem.

The Modern GPS Receiver (12 channel GPS)

Modern GPS receivers normally have 12 or more channels which can receive data from 12 different satellites simultaneously. Satellites are moving fairly rapidly along their paths and the ability of the receiver to ‘lock’ onto a large number of satellites means that they are always using the best data available. It also means that their ‘start-up’ times are very quick. The oldest receivers have very few channels, so they have to divide their time between using data from only one or a few satellites and searching for new ones. They are inherently slow.

How could GPS use in navigating objects?

GPS receivers take signal information and calculate the user's exact location. Now, the receiver can determine the user's position and display it on the unit's electronic map. Your current location can be viewed in the GPS in the form of coordinates (latitude, longitude and altitude). If you are moving, your receiver may also be able to calculate your speed and direction of travel and give you estimated the distance to destinations and times of arrival to specified destinations. Besides, the locations and the route travelled can also be recorded.

There are three major Global Positioning Systems in use.

- The American Navstar System.
- The Russian Glonass System.
- The Europeon Galileo System.

Chapter 5: VHF - Marine Communication System

VHF - Marine Communication System

Marine radio systems are similar to having a conversation on the telephone, but with significant differences that the marine radio conversations could be listen by many people. An electronic device that performs in receiving radio signals called a radio receiver or a radio. There are several types of marine radios with different frequencies MF, HF and VHF, and, are identified by the mode of transmission.

- Very High Frequency (VHF) is transmitted within the frequency range 156-162 MHz, used for local, short-range marine communications. Clarity in the communication and effective range depends mainly on the height of antennas of both the receiving and transmitting stations and power output of the transmitting station. VHF equipment is called “line-of-sight radio” because its radio waves travel in nearly a straight line, meaning, if one antenna can “see” another antenna, communications between the two is possible.

- Medium Frequency (MF) is used to communicate for long distances. The MF band uses low frequencies, so the ground wave travels along the surface of the earth, permitting communications at distances up to 200 miles during daylight hours. The low frequency also makes communications at much greater distances at night easier. In general, MF and HF radios will always have greater range than VHF.

Very High Frequency (VHF) marine radio is essential communication equipment for fishing vessels operating in coastal waters. It allows instant communication between boats of in that area and port stations. T he VHF is the most valuable equipment for safety communication and any call for assistance of nearby vessels and coast stations. **VHF is not a telephone** and radio conversations are not private. When you talk on the VHF, everyone within range tuned to that channel is listening. The users of VHF should not use the equipment for private talk sand to chat. VHF has the advantage that equipment is relatively simple, and can therefore be compact and low cost.

VHF sets occupying the 156-162MKz band and generally considered the most suitable for short range (25-40 miles) marine communication. In the VHF system, different channels are set aside for ship-to-ship, ship-to-shore, safety, distress and calling and other specialized uses.

Simplex/duplex mode of communication

Duplex- In the duplex system, the transmitter and the receiver are tuned to two different (or paired) frequencies permitting communication in both directions simultaneously.

Simplex- In this mode, one person cannot be a talker and listener at the same time during a communication process. When a person at one end talks, the person at the other end listens and vice versa.

Working Principle

When the magnetic lines of force of a radio wave out across a receiving antenna, a voltage causes a current to flow between the antenna and ground. The antenna of the radio receiver will separate the desired signal with particular frequency from the available signals. The process of selecting the frequency is called tuning. The signal received after tuning is the modulated radio frequency carrier of a particular transmitter is very weak and requires amplification. Then the amplified modulated signal is fed into a demodulator for recovery of audio frequency from the carrier waves. Conversion of the audio frequency signal into sound waves is done by loudspeakers.

The following are the six steps in receiving radio signals:-

1. Radio waves of many frequencies and from many sources induce electric current in an antenna

2. A tuner selects the modulated carrier signal of the desired frequency.

3. The signal is modified.

4. The audio frequency signal is separated from the radio frequency carrier.

5. The audio frequency signal is amplified.

6. The electrical audio frequency signal is converted into sound waves.

Identification of Radio Telephony Stations:

Radio telephony communication mainly between ship to shore or shore to ship or ship to ship. There are 13 shore stations called **coast stations** are operated by the Department of Telecommunication, Government of India, along the Indian coast. Bombay and Madras are the **two major coast stations** operating in the MF, HF and VHF bands. Other 11 stations namely Kandla, Okha, Porbandar, Ratnagiri, Goa, Manglore, Cochin, Tuticorin, Port Blair, Visakhapatnam and Calcutta operate in the MF band. Of these Calcutta, Visakhapatnam, Port Blair and Cochin operate also in the VHF band.

Advantages of Marine VHF Radio

- Easy to use
- Good clear reception
- Reasonable range of coverage for small fishing vessels
- Low power requirements make battery operation possible
- VHF facilitates reasonable antenna sizes
- Portable and hand held sets are available
- The relatively low cost of appliances has lead to their great popularity

Operating procedures for non-emergency calls:-

The standard calling procedure for a non-emergency call through VHF is as follows,

1. Name of station being called, say clearly for three times.

2. The words "THIS IS", say once.

3. Name of your vessel, say once.

4. Say “OVER".

5. Then wait for the station being called to answer. Their answer should be in the same manner as you called.

6. Once answered you should suggest a specific working channel to carry on your conversation.

7. The word "OVER"

8. Wait for reply or confirmation from the station being called, switch to the working channel and repeat the process.

Emergency Voice calls through marine radio communication

When an emergency occurs at sea, the degree of urgency could be expressed by using proper pro-words on marine radio communication. The following are the important pro-words commonly used on marine radio communication,

- **MAYDAY** is used to express distress of the highest priority. It should be used only when a boat is threatened by grave or imminent danger and requires immediate assistance. Broadcast the distress on 2182 kHz or Channel 16. A MAYDAY call has absolute priority over all other transmissions and the message will be heard by all the listeners of channel 16. All boat operators hearing a MAYDAY call should immediately pay attention.
- **PAN-PAN** (*pahn-pahn*) is the spoken word for communicating a very urgent message to transmit concerning the safety of a ship, aircraft, vehicle, or person.
- **SECURITY** (*SEE-CURE-IT-TAY*) is a safety related spoken word to indicate a message concerning the safety of navigation, or important weather warnings.

To attract the attention of listeners, the sound alarm consists of two audible tones of different pitch sent alternately, for not less than 30 seconds or more than one minute. When a distressed boater is in your vicinity, receipt of the distress message should be acknowledged at once. If the distressed vessels are far away from your vessels position the message may be passed to nearby vessel or shore stations.

Operating procedures for emergency calls

The emergency calls are to be used **ONLY** in an emergency in which the boat and/or persons on board are in imminent danger of sinking or major injury or death. The following is the procedure for transmitting the emergency calls,

1. Tune the marine communication system to Channel 16.

2. Distress spoken word “MAYDAY", for three times.

3. The say "THIS IS", for once.

4. Name of vessel in distress (spoken **three** times).

5. Repeat "MAYDAY" and name of vessel, spoken once.

6. Give position of vessel by latitude or longitude and distance to a well-known landmark if available. Include any information on vessel movement such as course, speed and destination.

7. Say nature of distress (sinking, fire etc.).

8. Kind of assistance required.

9. Number of persons on board.

10. The word "OVER"

Listen for reply. If there is no reply, repeat the procedure once again till you get reply.

Mayday Procedure

(Hint - Mayday procedures carry most marks on the assessment paper - For Mayday Procedure –Remember the Acronym **M I P DA N I O**)

Making a ‘typical’ Mayday call

‘Mayday, Mayday, Mayday’

‘This is (say name of vessel three times)’

M (**MAYDAY**) ‘Mayday’

I (**IDENTIFY** yourself again) ‘This is... (Say name of vessel and mmsi no. if known)’

P (**POSITION**) ‘Where in position... (Say position)’

D (nature of **DISTRESS**) ‘We are... (Say what danger you are in)’

A (**ASSISTANCE** required) ‘Request immediate assistance’

N (**NUMBER** onboard) ‘We have... (Say number of people onboard)’

I (other **INFORMATION**) ‘We are... (Describe vessel or any other useful info.)’

O (**OVER**) ‘Over’

General Rules for using VHF

- English is the international language of marine communication
- Conversation must be as short as possible with decent language
- As many conversations are safety related, there is a need to have un-ambiguous and precise dialogue
- Transmit the emergency calls only with the approval of the authority of the vessel only in an emergency situation.
- Operate the radio telephone with the qualified person.
- Use frequencies or channels allotted for you
- Limit the conversations to only to the required duration,
- Remember that everything you say can be heard by anyone who has a VHF radio. · While the radio is turned on, watch the Distress Channel 16 (2182 kHz).
- Use phonetics to spell out difficult words or abbreviations.
- Do not interrupt or interfere with transmissions already in progress wait for an appropriate break before starting your call.
- Know the correct procedures for making and dealing with distress messages and traffic and train others on board how to receive and make calls.
- The most commonly misused procedure words are "Over and Out." "Over" means that you expect a reply. "Out" means you are finished and do not expect a reply. It is contradictory to say "Over and Out."

Common Pro Words used in Marine Radio Calls

- **'This is' -** For identifying yourself at the start of a call
- **'Over' -**I have ended my transmission but awaiting reply
- **'Out' -** I have ended my transmission and do not expect a reply
- **'Radio Check' -** Please comment on my signal strength & transmission quality
- **'Station Calling' -**Used when you do not hear the call sign of the station calling you
- **'Say again' -** Please repeat what you have just said ('I say again' - I will repeat what I have just said
- **'I spell' -** I am going to spell the last word I said using the phonetic alphabet

Chapter 6: Radio Direction Finder

Radio Direction Finder (RDF)

A radio beacon is a wireless lighthouse, transmits radio signals at particular frequency from a place that is visible from navigational point of view. The transmitted radio signal is used for ships in taking radio bearings. There are many types of radio beacons used for sea and air traffic and position fixing purposes.

Types of Radio Beacon

1. AERO RADIO BEACON- mainly used by aircrafts and occasionally by ships. Operates continuously.

2. RADIO RANGE- unidirectional aero radio beacon whose transmissions only through definite air routes.

3. MARKER RADIO BEACON- operates continuously for short range (less than 10 nm) to mark a specific place.

4. CALIBRATION STATION- transmission for calibration of ships D/F receivers is known as a Calibration station. Available on request from one hour after sunrise to one hour before sunrise

5. DIRECTION FINDING STATION- wireless station mainly operated for taking radio bearings from vessels.

6. OCEAN WEATHER SHIPS- weather conditions in the North Atlantic and North Pacific Oceans, these ships are equipped with radio beacons In emergencies, these ships also provide D/F and Radar bearings.

7. **BEACONS FOR DISTANCE FINDING-** beacons emit synchronized sound and radio signals for distance finding.

8. FOG SERVICE BEACON- radio beacons operates only during fog times where the visibility severely affected.

Working of Radio Direction Finder

Radio Direction Finder (RDF) often referred as 'Radio Compass', is an important electronic radiolocation instrument for navigation of both aircraft and ships. It used for finding the direction of a radio signal transmitting source. It is one of the long range and reliable radio navigation system. RDF was introduced in 1930s and extensively used in air traffic. The RDF is still used in air and marine crafts, because of its simplicity. Fixing the vessel's position by radio bearing is very simple when compare to visual bearings.

The RDF is basically a radio receiver fixed onboard a vessel or aircraft, which has display unit and directional aerial (antenna) system. The directional antenna determines the direction of the incoming radio signal in relation to the ship's head. The radio signal in a particular frequency will be transmitted from a transmitter kept in coast station, radio beacon, light house beacon in the vicinity whose position is known. Establishment of radio bearing is possible from a vessel to a transmitting station. The established line of position is plotted on the appropriate chart. Similarly, a second line of bearing can be established from another radio transmitting station of known frequency .These two bearings are plotted to obtain vessel's position at particular time. It is also possible to take third line of bearing from yet another transmitting station to make the fix the vessel's position very accurately.

Function of Direction Finder

The Direction Finder performs two functions

1. Establish a line of position (LOP) along which the transmitting station and a vessel lie.

2. Determine the direction in which the transmitting station lies

Identification of radio Beacons

The technical details of the beacons positioned along the coasts are given in Admiralty List of Radio Signals and in List of Radio determination and Special Service Stations. The particulars such as frequency of transmission, time of operation (if applicable), range (or power output), position, duration of service, period of transmission etc.

Radio Gonio-meter (Loop antenna)

The Goniometer (*Gonio'* means angle and '*meter'* means measurer) measures the angle between the ship's fore-aft centre line and the radio transmitter from where the signals are received. It helps in obtaining the bearing of the radio transmitter relative to the ship's head. Goniometer consists of two fixed coils (also called field coils) placed at right angles to one another. The loops are connected through cables to their respective coils. The search coil is connected to the receiver input. The Goniometer aerial placed in the path of a radio wave will be cut by the alternating field and an EMF will be induced in it.

If the plane of this antenna pointed to a radio beacon, the signal strength will be the maximum, while a signal facing the loop induced voltages that cancelled each other out, resulting in a weak or null signal. The loop antenna was connected to an amplifier which will amplify the weak signal in to several thousand times.

Range of Transmission

Range of transmission is the distance in nautical miles at which the radio signal is received by the vessel. In some cases the transmission power is reduced during night hours and this will be mentioned in the list.

Automatic Direction Finder (ADF)

Automatic direction finding (ADF) is an improved version of basic radio direction finder. In ADF, the automatic rotation of the loop antenna will ensure that the signal is always a maximum. Two loop antennas, set up at a right angle to each other, and measure the ratio of the signals from each antenna to get the angle to the beacon. ADF is the radio navigation system still in use radio signals in the low to medium frequency band of 190 Khz. to 1750 Khz. The curvature of the earth is not a limiting factor for ADF. The range of operation mainly depends on the power of the beacon. Commercial AM radio stations broadcast on 540 to 1620 Khz. Non-Directional Beacon operate in the frequency band of 190 to 535 Khz. The following are the merits of Radio Direction Finder over other radiolocation systems

1) It is simple to use.

2) It can be used in any part of the world.

3) Bearing of any radio transmitter can be independently taken on board ship or aircraft..

4) Signal reception from the desired transmitter is possible by turning the loop antenna (or the Goniometer)

5) If there is no radio beacon in the vicinity of vessel, navigator will request the nearest port to transmit radio signals. Any one of the coast station or pilot vessels to transmit signals and thus act as radio beacons.

6) Signals from transmitting stations are usually very strong, so that a good bearing and position line can be obtained

Chapter 7: Autopilot-Automatic Steering System

Automatic Steering System or Auto-Pilot

The automatic steering device or the autopilot is an instrument controlling the steering system that automatically maintains the ship on a predetermined course. The autopilot must fulfil all the functions of the steering system under different conditions of steering in any type of ship. The use of thus instrument leads to a reduction in the running costs of a ship. This is used for steering the vessel without constant handling of steering wheel manually.

The basic functions of autopilot are

The desired course is set into the autopilot by the user and this course is compared in the autopilot with this actual course achieved. The difference between the two, this course error, is their acted on by the autopilot and an output signal is sent to this rudder control mechanism. This demanded rudder command corresponds to the helm or wheel order with the rudder control system in hand control.

The degree of success with which the autopilot will be able to control the ship is course depends on a number of factors. They are

1. The speed of the ship:

At zero ship speed, clearly any movement of the rudder will have no effect on the ship's course at all. As this speed increase the amount of rudder to be used for a given ship response will be less until, at maximum speed, a very small alteration will suffice. For this reason, the ship is speed is usually fed into the autopilot.

2. The Environmental condition:

The presence of wind and waves will affect the ship's response. In heavy quartering seas it is highly unlikely that the autopilot will be able to control the ship satisfactorily at all.

3. The condition of the autopilot:

4. The number of pumps running in the steering gear:

With two pumps running the rudder will move at approximately twice the speed at which it will operate with only one. In smaller ships this will have a marked effect on the turning ability.

System diagram of autopilot:

Input: Actual course, derived course and ship's speed

Output: Derived rudder angle.

Disturbances: wind and wave

Autopilot is a relatively simple device which relies entirely on ship borne sensors to function. The automatic steering device usually works with a gyro compass but can also work with the help of magnetic compass with a repeater system. The autopilot is in fact the main element of the system of continuous automatic control. This consists of a sensingelement-gyrocompass-a computing system with and amplifier and the steering device.

The system possess the feedback loops

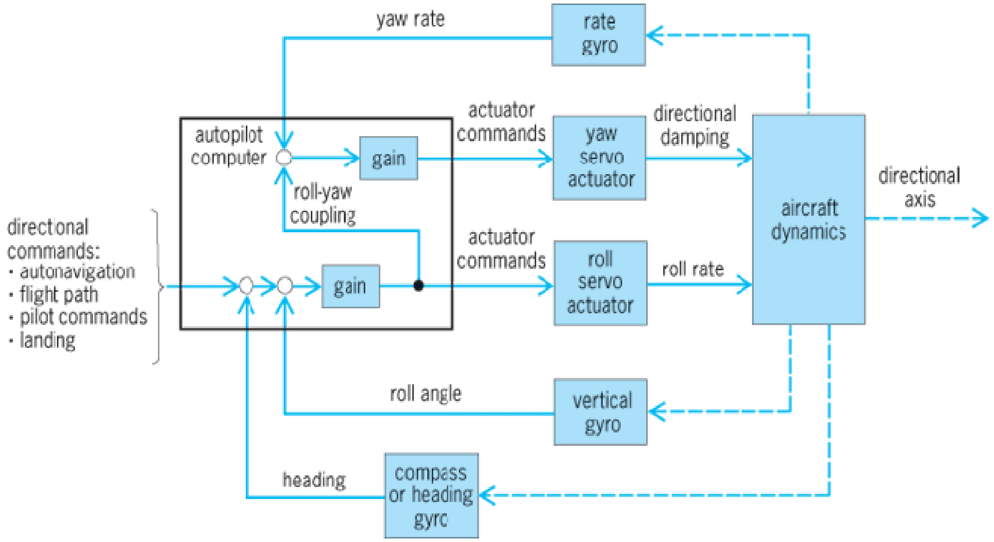
1. Internal – wheel –automatic steering device

2. External –wheel –one gyro compass

When the ship deviates from its predetermined course to starboard side. The synchro receiver (SR) of the gyro compass (GC) rotates this sensing element of the course (SEC), which generates our electric voltage proportional to the deviation of the ship from predetermined course.

Simultaneously the receiving synchro rotates the tacho generators (TG) which in turn generate electric voltage proportional to the rate, of change of deviation in the ship's course from predetermined course.

Both there voltages are fed to a summing system (SS). After amplification in the amplifier (A) the signal is fed to the actuating motor of the steering drive (SD) which will start to move the rudder to port. Simultaneously the steering pick-up (SP) will also rotate, in turn generating an electric voltage (V4) which is proportional to the deviation of the rudder.



Chapter 8: EPIRB and SART

Emergency Position Indicating Radio Beacon (EPIRB)

Emergency Position Indicating Radio Beacon (EPIRB) is a small, powerful and self-contained distress radio transmitter fitted in the ships and vessels. If the vessel is suddenly hit by any distress , such as sinking, fire, drifting, engine failure etc., the EPIRB is designed to float free and start emitting the radio signals. This electronic equipment is activated automatically on floatation in water, without the knowledge of the captain or when the crew is unable to send a distress message from the vessel. It possible to activate the EPIRB manually ("float-free" activation) .The transmission of an EPIRB signal is considered a distress alert.

The purpose of an EPIRB signal is to help determine the location of survivors during an emergency. The signals of EPIRB will be recognised by the satellite and transmit to Rescue Coordinating Centre (RCC) .This message contains code identifying the vessel as provided by the Administration and retained in a register for this purpose. The EPIRB is one of the main Electronic Equipment required under GMDSS (Global Maritime Distress and Safety System). The equipment, mounting and hydrostatic release mechanism must be reliable and able to operate under the most extreme conditions likely to be met at sea. Manual distress alert initiation requires at least two independent actions. All types of EPIRBs should be equipped with a low duty cycle flashing light of 0.75 Candela, which is automatically activated in the dark once the EPIRB has been activated.

EPIRB

Four synchronous satellites orbiting around the earth at a low attitude of 850 km. Each satellite takes 100 minutes to complete one polar orbit journey around the earth. Thus the satellite will available in the vicinity of the beacon, every hour. EPIRB operates at a frequency of 121.5m.Hz or 243 MHz and sends alert signal for 48 hours. The signals are picked up by rescue aircraft or by satellite. When a satellite receives a distress signal from an older EPIRB, it is immediately be transmitted to one of 15 ground stations worldwide.

EPIRB is programmed and loaded with a unique code for identity before it goes to on board a vessel. The identity includes a 3 digit country code. This is the country that takes responsibility for storing that particular EPIRB's registration details. When EPIRB is activated in an emergency, the nearest Rescue Coordination Centre (RCC) will receive the message and decode with registration database. Three registration forms are provided, two are for future use and one must be completed immediately.

A latest model EPIRB has advanced system with operation frequency of 406.025 MHz or with Immarsat system using a frequency of 1.6 GHz (International Maritime Satellite system). The code of EPIRB contains,

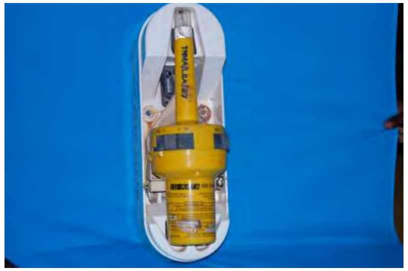
a) Type of vessel or ship

b) Country of registration

c) Beacon identification-The unique number referred to above.

d) Distress message – fire, sinking etc.

e) Position of EPIRB/vessel



Important features of EPIRB

1. EPIRB is powered by a Lithium battery that has a placement interval of 5 years.

2. Once activated it can emit signals for at least 48 hours.

3. It can be activated on floatation in water and manually while on board or in a life raft.

Aboard ship:

DO:

• Place the EPIRB in the open, clear of overhangs

• Keep the EPIRB upright (hold it if necessary)

• Switch on the EPIRB

DON'T:

• Place the EPIRB close to large structures

• Lay the ERIRB on its side

• Place the EPIRB under cover

OK

In a life raft:

DO:

• Make sure you switch on the EPIRB

• Hold the EPIRB up as high as possible.

Unit 7: SEAMANSHIP

Bad weather preparation

Sea going vessel needs the nature's favour for the successful completion of its voyage. The weather is one of the factors that determine the safe and timely arrival of the destination for every vessel including coastal fishing vessels. As we know the weather conditions are not always favouring the mariners, and the adverse conditions of Heavy /Rough/ Bad Weather are often experienced. The best way to handle bad weather is to go to shore immediately and avoid it completely. However, this may not be practical if the vessels are on an extended cruise. Every sea going person should know about the heavy weather conditions and preparations for the vessel and crew to face the bad weather conditions at sea. (The mariner should never use the boat other than for what it was designed and its intended use. The boat should not be tried beyond the boat's design capabilities.

The body of water on which the boat is operated, has a lot to do with how severe the conditions may get. While operating on deep and large bodies of water, wave action tends to build more slowly than on large waters that are shallower. In deep waters, wind action may only cause moderate seas with slow, rolling swells, while in shallower waters that same wind force may make steep, breaking seas.)

Weather and water conditions play a big role in your safety on the water. Before going out from the fishing harbour, the mariner should watch the latest weather forecast for that particular area. Indian Meteorological Department provides marine forecasts in many ways. If you have a marine radio, you can get weather updates while you're on the water. These forecasts provide information on wind speed and direction, weather, sea state wave actions etc,. Whenever a coastal strip is affected by bad weather, weather warnings for fishermen are broadcast in regional languages by All India Radio.

Points to be noted during bad weather preparation

Handling the vessel under bad weather condition is one of the seamanship techniques. This knowledge could be gained only through practice. However, the preparation for bad weather could be done by all those who are connected with vessels. The following are the important points pertaining to bad weather preparation,

1) **Reduce the vessel speed**. The reduction in speed will reduce the strain on the hull and superstructure of vessel.
2) **Give fog signals** and **switch on the navigational lights** at restricted visibility.
3) **Restrict the person's movements on the open deck.**
4) **Inform the engine room and galley** about the state of weather.
5) **Watch the weather warnings for fishermen and follow.**
6) **Suspend the fishing operation,** if it is not favouring the vessel movement.
7) **In case of a cyclone return to the nearest port**

Other points are:

8) Start pumping bilge water, monitor the water level in the bilge and repeat the pumping as and when required. (Water in the bilge may affect the stability)
9) Increase the look-out.
10) Remove all movable articles from the deck
11) Secure mooring ropes and anchor properly
12) Close all hatches water tight.
13) Remove the awnings and fittings.
14) Lower the derrick
15) Study the sea conditions change in weather frequently.
16) Keep ready a sea anchor

    (**Sea Anchor** - A floating canvas cone, attached with a rope bridle at the larger to the bow of the boat. It is used in storm conditions to keep the bow of the boat into the wind, and slow the downwind drift of the boat.
17) Keep your anchor ready with suitable rope.
18) Make sure the life raft is ready for launching.
19) Plans to go to sheltered waters if possible.
20) Fix your vessel position both electronically and on chart.
21) Keep ready emergency items (hand pumps, first aid kit, sound signalling device)
22) Secure all loose gears above decks and below.
23) Determine position of storm, wind direction, speed.
24) Explain the situation to the crew members. Make them to understand the condition and cooperate and act accordingly.

PRECAUTIONS AND EMERGENCIES

MAN OVERBOARD

It may sometimes happen that man may fall overboard accidentally. The following swift and actions are necessary to save the man.

1. Immediately shout "**man overboard, starboard** / **port**" as the case may be
2. *Turn the wheel hard over to the side in which man has fallen* to clear him from the propeller and stop the vessel.
3. Throw to him a **life buoy** and if it is **night**, fitted with a **self-igniting light.**
4. Hoist **'O' flag** and inform the neighbouring vessel if **VHF** is provided.
5. Post a man as high as practicable for the look out.
6. Approach him slowly and keep him on the side of the vessel and carefully lift the man and give him first aid.
7. Make an entry in the log book
8. Find out the reason for the incident and take all necessary precautions to prevent such incidents in future.

PRECAUTIONS DURING FISHING

A lot of precautions should be taken during the fishing operation so that the operation will be smooth, without any accidents and injuries

The following are the precautions:

1. During shooting and hauling great care should be taken to see that the net is clear of the propeller.
2. Deck should be clear and not slippery.
3. Keep clear of the moving fishing gears.
4. Post only experienced crew for the operation of winch.
5. Hoist proper fishing ***signals*** during ***day and night.***
6. Handle the catch carefully and use ***gloves, gun-boots*** etc.
7. Inspect the lifting locks, ropes, warps at frequent intervals for any damage.

8. Do not conduct the fishing operation in the submarine cable, pipe lines areas and places where fishing is prohibited.
9. Keep proper look out and avoid ***collision*** and ***close quarters*** situations with other vessels.
10. Do not stand under the blocks while lifting the catch.
11. Do not wear loose clothes, bangles, rings, chain etc.
12. While lifting heavy catches, great care should be taken to avoid accidents.
13. Keep a close watch on the sea conditions, especially during disturbed weather.
14. When net come fast on an obstruction, clear it very carefully keeping in mind the stability of the vessel.
15. All the work on board should be supervised by an experienced officer.
16. Refer the ***notices*** to mariners and ***chart*** to avoid firing practice areas, wrecks, rock spoil ground and rocket launching areas, etc.

Pre preparation check list for medium sized fishing vessels

1. Lifesaving appliances

(i) Approved lifejacket for everyone on board.
(ii) Approved Life buoys
(iii) Buoyant apparatus
(iv) Distress signals

2. <u>Navigational equipments /instruments</u>

- Magnetic compass
- GPS / Chart plotter
- Sounding equipments
- wind vane
- Speed log
- VHF / Cell phones

3. <u>Electrical Equipments and installations</u>

- Interior and navigational lights
- Fuse breaker panel
- Alternators
- Battery charge

4. <u>Engine</u>

- Oil check
- Fuel check
- Coolant check
- Spare oil
- Belts
- Tools
- Fuel level gauges
- Spare hoses
- Spark plug for petrol engine
- Trouble shooting guide

5. <u>Cabin</u>

- Life jackets
- Tool kit
- Charts
- Tide table
- Flashlight / batteries
- Binoculars
- First aid kit
- Manuals for equipments
- Signal flags and lights

6. <u>Deck</u>

- Anchor
- Cable and ropes
- Oars
- Anchor
- Bilge pumps
- Manual bilge pump
- Water tanks
- Life buoy

7. <u>Galley</u>

- Gas
- Fire extinguishers
- Food materials