

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 some times 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.
- importance was first recognized by the ancient Mediterranean mariners; a lighthouse was built at Sigeum, near Troy, before 600 B.C.,

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.

- **Types of buoys**
- **Can buoy** -can buoys is cylindrical
- **Spar Buoys**-large logs, trimmed, shaped, and appropriately painted
- **Nun buoy**-nun buoys is conical
- **Lighted buoy**-carry batteries or gas tanks and are surmounted by a framework supporting a light
- **Bell buoy**-have flat tops, surmounted by a framework supporting a bell

- **Gong buoy**-have a series of gongs, each with a different tone
- **Whistle buoy**-they carry a whistle sounded by the sea's motion or horns that are sounded at regular intervals by mechanical or electrical means.
- **Combination Buoys**-light and sound signal are combined, such as a lighted bell, gong, or whistle buoy.
- **Station buoys**-do not always maintain exact positions, especially during the winter months or when moored in exposed waters

- **Importance/Significance of buoys** -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.

Marine buoyage system

- Before 1976, there was no common buoyage system; there were about 30 different buoyage systems were in use throughout the world.
- During 1980 (IALA) ,(IHO) (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.
- Only lateral marks differ between buoyage regions A and B, where as other 4 types are

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 Phillipines)**

- They follow red colour buoy to port side and green colour to star board side green to port side.
- ***The general direction taken by the mariner when approaching a harbour river, estuary or other waterway from seaward.***
- **Port mark**
- **Colour:** red.
- **Top mark:** can shape
- **Light:** a red light may be shown..
- **Starboard mark**
- **Meaning:** when 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** :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 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

Types of cardinal marks

- **North cardinal mark**
- **Meaning:** pass to North.
- **Colour:** black band above yellow band.
- **Top mark:** cones points up.
- **Light:** white light continuous flash.

East cardinal mark

- **Meaning:** pass to East.
- **Colour:** black bands above and below yellow band.
- **Top mark:** cones points outward.
- **Light:** white light three flashes.

South cardinal mark

- **Meaning:** pass to South.
- **Colour:** black band below yellow band.
- **Top mark:** cones points down.
- **Light:** white light six flashes and one long flash

West cardinal mark

- **Meaning:** pass to West.
- **Colour:** black band between yellow bands.
- **Top mark:** cones points inward.
- **Light:** white light nine flashes.
- **Isolated danger marks**

Isolated Danger Mark

- 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.

- **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.

- **Meaning:** the 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 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 mark**
- 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 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.
- The top mark, if fitted, is a standing/upright yellow cross

- 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.

- 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.

Light ships

- 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.
- **Identification of lights** 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.
- vessel will be mislead when the navigator fail to identify lights correctly
- The colour of the light and flashing characteristics in a full cycle should be carefully noted by the navigator.

Flashing:

- Flashing – when the time on is less than they are off.
- light is flashing at the rate of not more than 30 per minute
- **Interrupted Quick Flashing** : 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.
- 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**
- visibility of light is a specific distance, in nautical miles, a navigator is expected to see a lighthouse or beacon.
- **Horizon distance (Distance of visibility):** The 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.
- **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.
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- **Types of Radio beacons**
- **1. AERO RADIO BEACON-**
- **2. RADIO RANGE-**
- **3. MARKER RADIO BEACON**
- **4. CALIBRATION STATION-**
- **5. DIRECTION FINDING STATION**
- **6. OCEAN WEATHER SHIPS-**
- **7. BEACONS FOR DISTANCE. FINDING**
- **8. FOG SERVICE BEACON-** radio beacons operates only during fog times where the visibility severely affected.
- 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.
- 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.

- **Day Beacons**
- **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 the bottom, on which are placed one or more signboards called “daymarks” which convey information through their color, shape, and lettering or numbers.
- **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,. 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.

- **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.

- eled 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.

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