Chapter 11

NAVIGATION AND AIDS TO NAVIGATION

Fixing the position

General information

11.1

The position of a ship at sea can be found by several means. Traditional methods have involved two or more position lines obtained with reference to terrestrial or celestial objects and resulting position lines may be plotted on a chart or converted to latitude and longitude. It must be emphasised that a fix by only two position lines is the most likely to be in error and should be confirmed with an additional position line or by other means.

Satellite navigation methods are being increasingly used for many types of navigation with the output of a position. However, the fact that the position may be referred to a datum other than that of the chart in use **must** be taken into account. See 1.33.

On coastal passages a ship's position will normally be fixed by visual bearings, angles or ranges to fixed objects on shore, corroborated by the Dead Reckoning or Estimated Position. The accuracy of such fixes depends on the relative positions and distances from the ship of the objects used for the observations.

Radar or one of the radio position–fixing systems described below may often give equally, or more accurate, fixes than visual ones, but whenever circumstances allow, fixing should be carried out simultaneously by more than one method. This will confirm the accuracy of both the observations and the systems.

Visual fixes

Simultaneous bearings

11.4

A fix using only two observations is liable to be affected by undetected errors in taking the bearings, or in applying compass errors, or in laying off the bearing on the chart. A third bearing of another suitably placed object should be taken whenever possible to confirm the position plotted from the original bearings.

Simultaneous bearing and distance

11.5

In this method the distance is normally obtained by radar, but an optical rangefinder or vertical sextant angle (see below) may be used. An approximate range may also be obtained by using the "dipping distance" of an object of known height and the Geographical Range Table given in each volume of *Admiralty List of Lights*, or in other nautical tables or almanacs.

It should be noted that the charted range of a light is not, except on certain older charts, the geographical range. See 11.84.

Running fix

11.6

If two position lines are obtained at different times the position of the ship may be found by transferring the first position line up to the time of taking the second, making due allowance for the vessel's ground track and ground speed. Accuracy of the fix will depend on how precisely these factors are known.

Transit

11.7

To enable a transit to be sufficiently sensitive for the movement of one object relative to another to be immediately apparent, it is best for the distance between the observer and the nearer object to be less than three times the distance between the objects in transit.

Horizontal sextant angles

11.8

Where great accuracy in position is required, such as the fixing of a rock or shoal, or adding detail to a chart, horizontal sextant angles should be used when practicable. The accuracy of this method, which requires trained and experienced observers, will depend on the availability of three or more suitably placed objects. Whenever possible about five objects should be used, so that the accuracy of both the fix and the chart can be proved.

A horizontal sextant angle can also be used as a danger angle when passing off–lying dangers, if suitably placed marks are available. This method should not be used where the chart is based on old or imperfect surveys as distant objects may be found to be incorrectly placed.

Vertical sextant angles

11.9

Vertical sextant angles can be used for determining the distances of objects of known height, in conjunction with nautical tables. A vertical angle can also be used as a danger angle.

It should be noted that the charted elevation of a light is the height of the centre of the lens, given above the level of MHWS or MHHW and should be adjusted for the height of the tide if used for vertical angles.

The height of a light structure is the height of the top of the structure above the ground.

Vertical angles of distant mountain peaks should be used with circumspection owing to the possibility of abnormal refraction.

Astronomical observation

General information

11.10

An accurate position may be obtained by observations of at least four stars suitably separated in azimuth at evening or morning twilight, or by observation of a bright star at daybreak and another shortly afterwards of the sun when above the horizon (not less than 10°). The position lines obtained from the bodies observed should differ in azimuth by 30° or more. Care should be taken in obtaining a probable position if it has been possible to observe only three stars in the same half circle of the horizon.

Moon sights are sometimes available when stars are obscured by light cloud, or in daytime. A good position may often be obtained in daytime by simultaneous observations of the Sun and Moon, and of the planet Venus when it is sufficiently bright.

The value of even a single position line from accurate astronomical observations should not be overlooked. A sounding obtained at the time of the observation may often indicate the approximate location on the position line.

Radar

Fixing

11.11

It is important to appreciate the limitations of a radar set when interpreting the information obtained from it. For detailed recommendations on fixing by radar, see *Admiralty Manual of Navigation*.

In general the ranges obtained from navigational radar sets are appreciably more accurate than the bearings on account of the width of the radar beam. If therefore radar information alone is available, the best fixes will be derived from use of three or more radar ranges as position arcs.

For possible differences between radar ranges and charted ranges when using charts based on old surveys, see 1.29.

Radar clearing ranges

11.12

When proceeding along a coast, it is often possible to decide on the least distance to which the coast can be approached without encountering off–lying dangers. Providing the coast can be unmistakably identified, this distance can be used as a clearing range outside of which the ship must remain to proceed in safety. A radar clearing range can be particularly useful off a straight and featureless coast.

Parallel index

11.13

Parallel index technique is a refinement of the radar clearing line applied to the radar display. It is a simple and effective way of monitoring a ship's progress by observing the movement of the echo of a clearly identified mark with respect to lines drawn on the radar display parallel to the ship's track. It is of particular use in the preparation of tracks when planning a passage.

Radar horizon

11.14

The distance of the radar horizon under average atmospheric conditions over the sea is little more than one third greater than that of the optical horizon. It will of course vary with the height of the aerial, and be affected by abnormal refraction (see NP 100 7.42).

No echoes will be received from a coastline beyond and below the radar horizon, but they may be received from more distant high ground: this may give a misleading impression of the range of the nearest land.

Quality and accuracy of radar returns

11.15

Radar shadow areas cast by mountains or high land may contain large blind zones. High mountains inland may therefore be screened by lower hills nearer the coast.

Fixes from land features should not be relied upon until the features have been positively identified, and the fixes found consistent with the estimated position, soundings, or position lines from other methods.

Metal and water are better reflectors of radar transmissions than are wood, stone, sand or earth. In general, however, the shape and size of an object have a greater effect on its echoing properties than its composition. The larger the object, the more extensive, but not necessarily the stronger the echo. Visually conspicuous objects are often poor radar targets. The shape of an object dictates how much energy is reflected back to the radar set. Curved surfaces, such as conical lighthouses and buoys, tend to produce a poor echo. Sloping ground produces poorer echoes than steep cliffs, and it is difficult to identify any portion of a flat or gently shelving coastline such as mud flats or sand dunes. Moreover, the appearance of an echo may vary considerably with the bearing.

Radar image enhancement

11.16

Radar beacons, either racons or ramarks, give more positive identification, since both transmit characteristic signals.

> **Racon.** A racon is a type of radar transponder beacon which, on receipt of a radar pulse, will respond on the same frequency, leaving an image on the radar display in the form of a series of dots and dashes representing a Morse character, radiating away from the location of the beacon. Most racons respond to both 3 centimetre (X–band) and 10 centimetre (S–band) radar emissions, but some respond to 3 centimetre emissions only.
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> **Ramark.** A ramark is a radar beacon which transmits continuously without having to be triggered by an incoming radar pulse. The image on the radar display is a line of dots and/or dashes radiating from the centre to the edge, with no indication of range. Only a few ramarks remain in existence, and those only in Japanese and Chinese waters.

Radar beacons should be used with caution as not all are monitored to ensure proper working. Furthermore, reduced performance of a ship's radar may fail to trigger a racon at the normal range. The displayed response of radar beacons may also be affected by the use of rain clutter filters on radar sets to the point where the displayed response signal is