On charts, all lights are shown as being white, unless another colour is given adjacent to the characteristics of the light. When the light includes different sectors of which one or more are white, the colour of the white light is then also expressly mentioned (Figures 2.34 till 2.37).

Examples

Fl R 5s

Figure 2.34

Q G

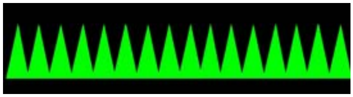

Figure 2.35

Fl(3) R 30s

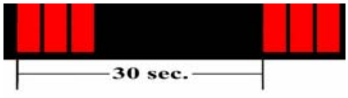

Figure 2.36

Al.Fl(3) WRG 15s

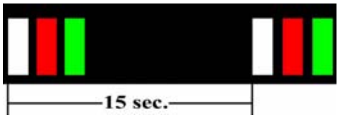

Figure 2.37

2.5.6 Elevation (or height above the water)

The elevation (or the height above water) of a light is the vertical distance between the focal plane of the light and sea level.

In tidal waters the level of the sea is:

— for English lights : Mean High Water Spring (MHWS) or Mean Higher High Water, whichever is given in the Admiralty Tide Tables;
— for American lights : Mean High Water;
— for French lights : Mean High Water Ordinary Spring (niveau de pleine mer moyenne de vive-eau);
— for Dutch lights : Mean Tide Level (het middenstandsvlak);
— for Belgian lights : Mean Tide Level Zo (de middenstand van de zeespiegel Zo).

2.5.7 Indication of elevation in the lists of lights

Elevations are indicated in metres in a separate column (see Plates I, IV, V, VI, VII and VIII).

In the American Light List, the elevations are given in feet (Plate V). In the American List of Lights the elevations are given in feet (roman type) and in metres (bold type).

2.5.8 Indication of elevation on charts

On charts, elevations are given in feet or metres next to the period of the light. This elevation is called the “charted height”.

Example

English charts: Fl(3) 30s 143 ft
Fl10s 40m

2.5.9 Use of elevation

2.5.9.1 TO FIND THE DISTANCE

When the elevation of a light or the height of an object above sea level is known it is possible, with the help of a sextant, to measure the height of this light or object, that is to say, the angle formed by the light or object and the horizon, and thus to determine the distance from the observer to that light or object. By taking simultaneously a compass bearing of the light or object, the ship's position can be determined with great accuracy.

The principle of the calculation of the distance off, by means of the vertical sextant angle, is based upon the calculation of the right side of a right-angled triangle, which is formed by the observed object and the observer's eye.

Figure 2.38 shows such a right-angled triangle ABC where h is the height of the object, B the eye of the observer, A the vertical sextant angle and, D is the distance between the observer and the base of the object.

The arc drawn with A as centre and AB as radius determines the observer's position line (Figure 2.39).

An exact calculation of the distance off would require triangle ABC to be a perfect right-angled triangle thus :

a. the height of tide is conforming with the level of MHWS;
b. the observer is at sea level, so the height of his eye is nil;
c. the surface of the earth is flat;
d. there is no refraction;
e. the object is perpendicular above the intersection point sea-earth.

In practice, the height of the tide and of the observer's eye are seldom taken into account (Figure 2.40). Disregarding these factors can only make the observer believe that he is closer to the object than he is in reality which can only increase the safety of navigation. The heights of objects are always given from the level of MH-

WS. For accurate results due allowance must be made for the tide and for the height of the observer's eye.

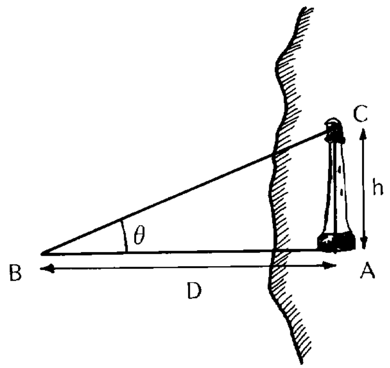

Figure 2.38

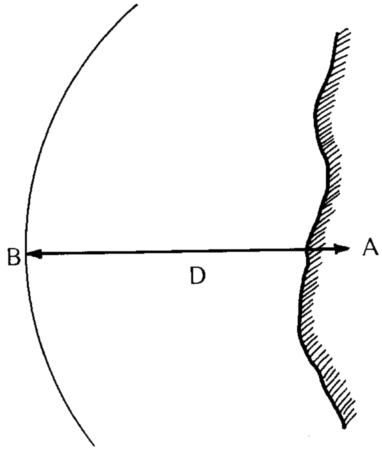

Figure 2.39

NOTE

As the lists of lights and the charts give the height of the focal plane it is the centre of the lantern and not the top of the lighthouse that should be reduced to sea level (MHWS).

The distance off can be calculated theoretically by plane trigonometry or can be found by utilising vertical sextant angle tables.

2.5.9.1.1 Theoretical calculation

Angle ABC = 0 is the angle subtended by the object (lighthouse or the like) and measured with the sextant. AC = h is the height of the lighthouse above sea level (usually MHWS).

Find the distance off AB = D (Figure 2.40).

When, for practical purposes, the height of the tide and of the observer's eye are not taken into account, then triangle ABC can be regarded, without much error, as being right-angled. AB and AC are then its right sides.

In plane trigonometry, the right side of a right-angled triangle is equal to the other right side multiplied by the cotangent of the adjacent angle. This gives us the following formula :

$$AB = AC \text{ cotg } 0$$

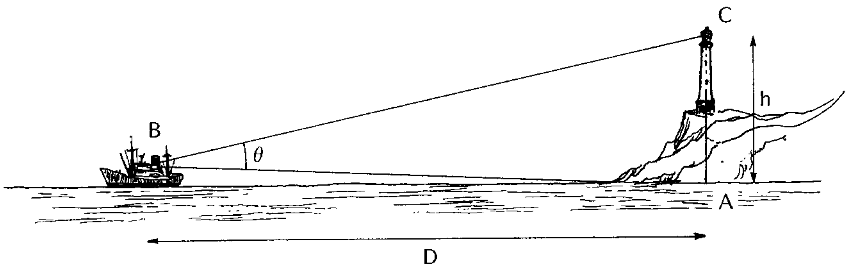

Figure 2.40

or after substitution of the corresponding elements:

D = h cotg 0

D can then easily be calculated with trigonometrical tables.

Example 1

The vertical angle of Dungeness Lighthouse, measured with a sextant, is observed as 0° 37'. The height of the lighthouse is 40 metres. (See Admiralty List of Lights, Volume A, No. 876 - elevation - and Chart 1892 Dover Strait.)

Find the distance off.

Solution

We use the above mentioned formula D = h cotg 0, in which :

h = 40 metres;
6 = 0° 37';
Cotg 0 = 92.9085 (see trigonometrical tables - natural cotangents).

After substitution of the respective elements in the formula we obtain:

D = 40 x 92.9085 metres or
D = 3716.34 metres.

To convert this distance from metres to miles, D should be divided by 1852 (one nautical mile = 1852 metres) which gives :

$$D = \frac{3716,34}{1852} = 2 \text{ miles (rounded off)}$$

2.5.9.1.2 Practical calculation

In practice, the calculations are seldom done, as special tables are available (See Table I,). Vertical sextant tables are found in most navigation tables.

All data which is necessary for the theoretical calculations is also found in these tables . It is

a. in *abscissa* the height of an object (roman type in feet and bold type in metres);
b. in *ordinate*, the subtended vertical sextant angle (in degrees and minutes).

The figures along the left-hand border give the required distance off in miles and cables (1 cable = 1/10 mile).

The heights of objects are given every metre up to 20 m, every 2 m up to 100 m, every 5m up to 150 m, every 10 m up to 300 m and every 25m up to 500m.

The distances are given every cable up to 3 miles and then every 2 cables. Interpolating is thus necessary for intermediate values.

Remark

To provide for converting English units to metric units, all heights of objects are given in metres with the corresponding values in feet beneath.

Use Table IV on page 269 for converting feet to metres.

Example 2

We take the same data as in example 1, and we use Table I.

The data required to use this table is the height of object, 40 m, and the subtended vertical sextant angle, 0° 37'. Along the column 40 m we look down until we see 0° 37'. At the same level on the left-hand border we find 2.0 miles, which is the required distance.

2.5.9.2 DETERMINATON OF THE VERTICAL DANGER ANGLE

The minimum distance at which a certain point such as a rock, shoal, etc. is to be passed can be determined by means of its vertical danger angle. In this case, the calculation is considered in reverse. The vertical sextant angle tables are entered with the height of object and the required distance. This gives the danger angle 0, which is the maximum angle that should be measured with the sextant. When this angle exceeds the stated maximum value the observer is nearer to the point of danger than he wishes to be. This vertical angle is known as the vertical danger angle.

Example 3

Using the same data as in example 1, the minimum distance required to pass Dungeness is 1 mile. Determine the vertical danger angle.

The vertical sextant tables are entered in the column 40 m. On the line corresponding with the distance of 1.0 mile on the left-hand border, we find the angle

1 °14'00", which is the maximum angle that should be measured with the sextant (Figure 2.41).

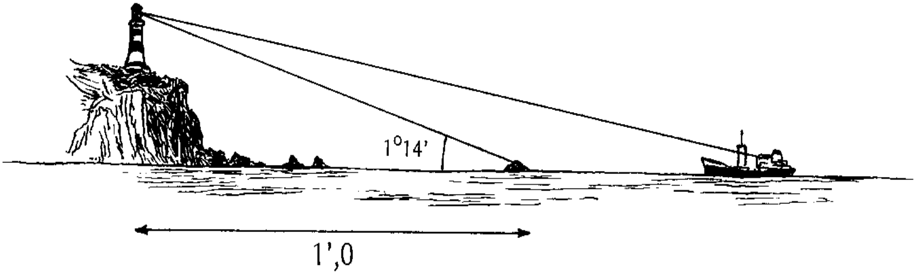

Figure 2.41