distance to the waterline of the obstruction in nautical miles.

Table 15. Distance by Vertical Angle Measured Between Sea Horizon and Top of Object Beyond Sea Horizon – This table tabulates the distance to an object of known height above sea level when the object lies beyond the horizon. The vertical angle between the top of the object and the visible horizon is measured with a sextant and corrected for index error and dip only. The table is entered with the difference in the height of the object and the height of eye of the observer and the corrected vertical angle; and the distance in nautical miles is taken directly from the table. An error may be introduced if refraction differs from the standard value used in the computation of the table.

The table was computed using the formula:

$$D = \sqrt{\left(\frac{\tan\alpha}{0.0002419}\right)^2 + \frac{H-h}{0.7349}} - \frac{\tan\alpha}{0.0002419}$$

in which D is the distance in nautical miles, α is the corrected vertical angle, H is the height of the top of the object above sea level in feet, and h is the height of eye of the observer above sea level in feet. The constants 0.0002419 and 0.7349 account for terrestrial refraction.

Table 16. Distance by Vertical Angle Measured Between Waterline at Object and Top of Object – This table tabulates the angle subtended by an object of known height lying at a particular distance within the observer's visible horizon or vice versa.

The table provides the solution of a plane right triangle having its right angle at the base of the observed object and its altitude coincident with the vertical dimension of the observed object. The solutions are based upon the following simplifying assumptions: (1) the eye of the observer is at sea level, (2) the sea surface between the observer and the object is flat, (3) atmospheric refraction is negligible, and (4) the waterline at the object is vertically below the peak of the object. The error due to the height of eye of the observer does not exceed 3 percent of the distance-off for sextant angles less than 20° and heights of eye less than one-third of the object height. The error due to the waterline not being below the peak of the object does not exceed 3 percent of the distance-off when the height of eye is less than one-third of the object height and the offset of the waterline from the base of the object is less than one-tenth of the distance-off. Errors due to earth's curvature and atmospheric refraction are negligible for cases of practical interest.

Table 17. Distance by Vertical Angle Measured Between Waterline at Object and Sea Horizon Beyond Object – This table tabulates the distance to an object lying within or short of the horizon when the height of eye of the observer is known. The vertical angle between the waterline at the object and the visible (sea) horizon beyond is measured and corrected for index error. The table is entered with the corrected vertical angle and the height of eye of the observer *in nautical miles*; the distance in yards is taken directly from the table

The table was computed from the formula:

$$\tan h_s = (A - B) \div (1 + AB) \text{ where}$$

$$A = \frac{h}{d_s} + \frac{\beta_o d_s}{2r_o} \text{ and}$$

$$B = \sqrt{2\beta_o h / r_o}$$

in which β_o (0.8279) accounts for terrestrial refraction, r_o is the mean radius of the earth, 3440.1 nautical miles; h is the height of eye of the observer in feet; h_s is the observed vertical angle corrected for index error; and d_s is the distance to the waterline of the object in nautical miles.

Table 18. Distance of an Object by Two Bearings – To determine the distance of an object as a vessel on a steady course passes it, observe the difference between the course and two bearings of the object, and note the time interval between bearings. Enter this table with the two differences. Multiply the distance run between bearings by the number in the first column to find the distance of the object at the time of the second bearing, and by the number in the second column to find the distance when abeam.

The table was computed by solving plane oblique and right triangles.

Celestial Navigation Tables

Table 19. Table of Offsets – This table gives the corrections to the straight line of position (LOP) as drawn on a chart or plotting sheet to provide a closer approximation to the arc of the circle of equal altitude, a small circle of radius equal to the zenith distance.

In adjusting the straight LOP to obtain a closer approximation of the arc of the circle of equal altitude, points on the LOP are offset at right angles to the LOP in the direction of the celestial body. The arguments for entering the table are the distance from the DR to the foot of the perpendicular and the altitude of the body.

The table was computed using the formulas:

$$R = 3438' \cot h$$

$$\sin\theta = D/R$$

$$X = R(1 - \cos\theta),$$

in which X is the offset, R is the radius of a circle of equal