

Vol IV, no 30

MEDICAL RESEARCH LABORATORY REPORT NO. 79

MEDICAL RESEARCH LABORATORY



U. S. Naval Submarine Base
New London

THE VESSEL LENGTH CALCULATOR

Prepared by

Lt. William B. Brown, USNR

Bu Med project X-271 (Av-159-c)

Report no. 4
(or Final and Final?)

12 October 1945

APPROVED FOR PUBLICATION
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THE VESSEL LENGTH CALCULATOR

Subject device -- The Vessel Length Calculator -- was designed and developed by Lt. William B. Brown and Lt. Richard T. Drukker, at NTS (Recognition), Ohio State University, Columbus, Ohio. Lt. Brown is now attached to the Lookout School, Medical Research Department, Submarine Base, New London, Connecticut; Lt. Drukker is now attached to the Naval Training School (Lookout Recognition), Gulfport, Mississippi.

This report is the first and final report

**Medical Research Department
U.S. Submarine Base, New London, Connecticut**

VESSEL LENGTH CALCULATOR

SUMMARY

This report deals with the design and use of a Vessel Length Calculator developed at NTS (Recognition), Ohio State University, Columbus, Ohio. While this device was originally intended to be used in the computation of the length of a vessel sighted at sea, under certain known conditions as outlined below, it has much broader applications to the field of navigation and surveying which, it is felt, could be of value to the Navy Department. A model of this device is submitted, along with a description of its use.

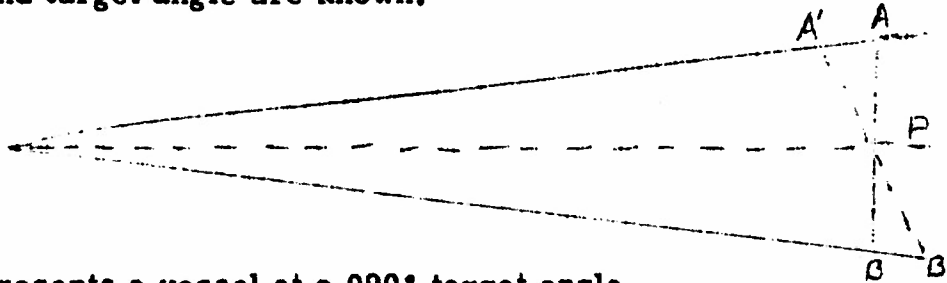
DESIGN

The Vessel Length Calculator is a circular slide rule designed to shorten the work involved in the mathematical computation of the length of a sighted vessel. The following conditions must be known: (1) the range of the vessel; (2) the angle subtended by the lines of sight to the bow and to the stern of the vessel; and (3) the target angle of the vessel. The range, item (1), is obtained from a rangefinder or radar; the angle, item (2), is measured by a sextant held in a horizontal plane and so manipulated as to bring the bow and the stern together; and the target angle, item (3) is calculated from radar plot, or by estimation.

The device itself is composed of two concentric discs, riveted at the center to permit the calibrations on the inner disc to be set opposite the calibrations on the outer disc. Each disc has two sets of calibrations. On the inner disc is read (1) the range and (2) the target angle correction. The range scale, given in units of 1000 feet, completely circles the edge of the inner disc. The calibration for target angle correction, called the Target Angle Scale, comprises only a small sector of the entire circle, and is located at the top of the inner disc. On the outer disc is read (1) the sextant angle setting and (2) the length of the sighted vessel, in feet. There are, however, three concentric bands of calibrations. The two outer bands are calibrated for the sextant angle, with the center band calibrated for angles from 7' through 59' and the outer band for angles of from 1° to 9°. The inner band is calibrated for the length of the vessel, in feet. Instructions for the use of the Vessel Length Calculator are printed on the face of the inner disc.

METHOD OF USE

The problem involved, illustrated in the diagram below, is to calculate the length of a sighted ship, AB or $A'B'$, where range, sextant angle and target angle are known.



AB represents a vessel at a 090° target angle.

$A'B'$ represents a vessel at 070° target angle.

Angle AOB and angle $A'OB'$ represent the angle formed by the lines of sight to the bow (OA or OA') and to the stern (OB or OB'), it is measured by a sextant.

OP represents the range of the sighted vessel.

Angle AXA' represents the angle of divergence from the perpendicular of $A'B'$ to OP , and is the basis of the target angle correction.

Without the Ship Length Calculator, the determination of the correct length of the sighted ship requires a rather complex and lengthy solution of a trigonometric problem. The range (OP) is multiplied by the tangent of the angle (angle AOB) measured by the sextant. This will give the length of ship AB , which is at a target angle of 090 , or on a course perpendicular to the line of sight to the ship (OP). When the ship is not on a 090 or a 270 course, however, this first calculation will give only the apparent length of the ship. To get the true length, a correction must be applied. This correction is made as follows: The amount of the angle (angle APA') in which the sighted ship diverges from the perpendicular to the line of sight is estimated; the previously determined apparent length of the ship (AB) is then divided by the cosine of this angle of divergence (angle APA'). This will give the true length of the ship ($A'B'$). This obviously requires a good deal of mathematical computation, as well as reference to trigonometry tables.

With the Vessel Length Calculator, however, all work is cut to a minimum through the application of the slide rule principle. Just two settings on the Calculator will give the result desired, (1) The arrow on the inner scale is set opposite the sextant angle reading on the proper sextant angle scale, (2) The apparent length of the ship is read from the ship length scale at the point opposite the range reading. (This will be the true length, as explained above, only if the target angle is 090 or 270). (3) To correct for

target angle the amount of divergence from the broadside is set in the target angle sector opposite the apparent length reading on the ship length scale. (4) The true length of the ship is read on the ship length scale opposite the arrow on the inner scale.

As an illustration, a typical example is taken for solution, referring to the above illustration. The following conditions are known: range (OP) is 5000 yards or 15,000 feet; sextant angle reading (angle A'OB') is $2^{\circ} 10'$; target angle is 070. The solution of the Ship Length Calculator follows: Arrow on inner disc is set opposite $2^{\circ} 10'$ on outer scale; apparent length of ship (AB), or 569 feet, is read opposite the range, 15,000 feet, (this scale is calibrated in units of 1000 feet); the angle of divergence from the perpendicular (angle APA') is obtained by subtracting the target angle, 070, from 090, or 20 degrees. This angle of divergence, 20 degrees, in the target angle scale is set opposite the apparent length of the ship, 569 feet; the true length of the ship, 606 feet, is read on the ship length scale opposite the arrow.

ADDITIONAL USES

In addition to the solution of the specific problem of vessel length calculation as outlined above, the Vessel Length Calculator could be used in the solution of any similar problem, where the three factors of range, angle formed by the lines of sight to the two extremities of the object, and the angle of divergence from the perpendicular of the line connecting the two extremities and the line of sight can be obtained. Basically, the Calculator has a definite application to many navigation and surveying problems, wherever it is desired to determine the distance between two sighted points. The procedure would be the same as that involved in the calculation of a ship's length, with any two desired points taking the place of the ship's bow and the ship's stern, and the line connecting these two points used in determining the angle of divergence from the perpendicular to the line of sight.

Thus the ship length calculator could be used anywhere, either at sea or on land, in the solution of navigation and surveying problems. Such problems as the width of a harbor entrance, the dimensions of a small island or reef, the height or width of a building, or the distance apart of two buildings--all can be determined quickly and easily, within the limits of the Calculator.

These limits, however, are broad. With a calibration of from $7'$ to 9° limits are as follows: at a range of one mile any dimension from a minimum of 12.2 feet to a maximum of 950 feet can be measured; at 10 miles range linear measurements upto 9,500 feet can be measured; at 10 miles range linear measurements up to 9,500 feet can be obtained.

One further limitation is to be found in the size of the angle of divergence. On the Ship Length Calculator it will be seen that no allowance has been made for such an angle larger than 45° . Due to the geometric increase in the amount of correction applied, it has been found that the Ship Length Calculator is not practical where this angle is larger than 45° , hence no calibration greater than this has been provided.

Other applications of the basic principle of this device are evident. Where the dimensions of the object are known, with the range the unknown factor, the calculator can be used as a range finding device. Where range and length are known, the Calculator will give target angle, or angle of deviation from the perpendicular of the line between the two extremities of the object to the line of sight to the object.

In use, it has proven to be as accurate as similar slide rule devices. Where range and sextant angle (this angle could be measured by a transit or other instrument as well) can be accurately determined, results with the calculator are quite accurate.