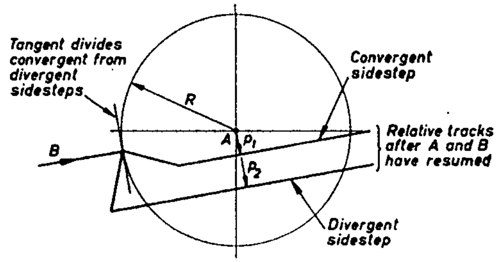

FIG. 2. Convergent and divergent sidestep manœuvres

The perpendiculars, p_1 and p_2, to the relative tracks *after both vessels have resumed* are obviously independent of the manœuvring range, R. In the divergent case, p_2 is *always* the nearest approach distance after both vessels have resumed course and speed. Divergency commonly arises when the closing speed is moderate or low, i.e. when the threat is abeam or astern. (See diagrams in this *Journal*, **14**, 397, 1961.)

In the convergent case, p_1 is the miss distance if the evasive manœuvre has been executed in 'proper time'. If not, then there may be a smaller miss distance on the relative track of B before A and B resume; but if this is so, then resumption has been delayed longer than was necessary. This delay is highly undesirable in narrow waters with congested traffic.

A System of Rules for Preventing Collisions at Sea

Rear-Admiral J. García-Frías

The following proposed system of rules was presented to the Collision Regulations Working Party of the Institute by Admiral García-Frías and is referred to in the January issue of the *Journal* (**24**, 56–9).

It is evident that the revision of the Collision Regulations would only be effective with a system of Rules able to cope with all situations that may arise at sea. The system must include all that it is necessary and sufficient to solve the collision problem in the easiest and most effective way and consequently it must apply both in clear weather and in restricted visibility using radar; differences between these situations being defined, if necessary, in every Rule.

The two sets of Rules the author has proposed in previous papers[1,2] were separately intended to solve these problems and an attempt is now made to recast both sets in the following system. It also includes manœuvring rules, which are not however so essential from the point of view of safety as those based on the organic aspect[3] of the collision problem.

Speed and prudential measures in fog

RULE 1

(a) Every vessel, or seaplane taxi-ing on the water, shall in fog, mist, falling snow, heavy rain, or any other condition similarly restricting visibility, proceed at a moderate speed not greater than 6 knots, having careful regard to the existing circumstances and conditions, if she does not use radar. A vessel using radar shall proceed at any speed greater than 6 knots.

(b) A power-driven vessel hearing the fog-signal of another vessel apparently forward of her beam, the position of which is not ascertained, and if using radar on reaching a distance of less than 1 mile from another vessel's echo, shall, so far as the circumstances of the case admit, stop her engines and then navigate with caution until the danger is over.

STEERING AND SAILING RULES

Responsibility for action

RULE 2. When a vessel is approaching another vessel so as to involve risk of collision, she shall reduce the risk by contributing to the rotation of the direction of the sight-line as her capabilities and the circumstances of the case admit. Risk of collision shall be deemed to exist if the bearing does not appreciably change and, in general, if there is the threat of a close-quarter encounter.

Operative zone for avoidance

RULE 3. Any avoiding action to be taken shall be made:

(a) By the vessel which has the other vessel ahead on her own starboard side:

by eye, in ample time and with due regard to the observance of good seamanship, if the manœuvre is possible. If not, or if she is uncertain as to the situation, she shall make clear her intention not to take the initiative;

by radar, when the other vessel's echo is at 2½ miles, if the alteration of course is to starboard.

(b) By the vessel which has the other vessel aft or on her own port side:

by eye, after she clearly sees the intention of the other vessel;

by radar, when the other vessel's echo is at 2 miles, for any alteration of course;

(c) If the vessel, directed in (a) to take action, does not do so and her cooperation is necessary;

by eye, after she clearly sees the intention of the other vessel;

by radar, when the other vessel's echo is at 2 miles.

RULE 4. Changes in course or speed, or both, shall be taken to check approach:

by eye, so that a close-quarter situation will be avoided;

by radar, before the distance reaches 1 mile.

Action to be taken

RULE 5. The action to be taken shall be, *by eye* or *by radar*:

(a) by turning,
if the bearing is less than 90° and $\left\{\begin{array}{l}\text{steady: to starboard;}\\ \text{changing: opposite to direction of change;}\end{array}\right.$
if the bearing is more than 90° and $\left\{\begin{array}{l}\text{steady: to port;}\\ \text{changing: in the direction of change;}\end{array}\right.$

(b) by decreasing speed, if desirable. (Only if the bearing is to starboard and steady or closing is this consistent with the turns prescribed in 5(a).)

RULE 6. If the vessel which should turn to starboard as specified in Rules 3(a) and 5(a) fails to do so, because of uncertainty or being a hampered vessel,

(a) *by eye*, the other vessel may turn to port after she clearly appreciates this impossibility;

by radar, the other vessel may turn to port when the vessel's echo is at 2 miles (because the bearing would not then be changing as it would be if that vessel had turned to starboard at 2½ miles);

(b) the other vessel may decrease speed, if desirable. (Only if the bearing is to port and steady or closing is this consistent with the turns prescribed in 5(a).)

Anti-collision bearings

RULE 7. Any alteration of course shall, if necessary, be made in such a way that the bearing of the other vessel remains,

by eye, greater than 30° port or 150° starboard;

by radar, greater than 60° port or 120° starboard.

Multi-vessel situation by radar

RULE 8.

(a) If at the beginning of, or during, the passing operation one vessel (or both) enters within radar contact at 2½ miles with a third vessel (or more) (which may in her turn be in the same contact with others) they shall steer, with regard to the nearest vessel of the convex contour (in an anti-clockwise direction) of the group so formed, with a port relative bearing as in Rule 7; or they shall carry out the action prescribed in 8(b).

(b) Every vessel on the contour, not intending to apply the port relative bearing specified in 8(a), and every vessel within the contour, shall proceed at a speed below 6 knots while in that situation, being then exempt from the provisions of 8(a). She shall, however, observe these provisions in relation to the inner vessels.

Narrow channels and bends therein

RULE 9. (The same context as Rule 25 of the Steering and Sailing Rules of the Collision Regulations.)

It is easy to see that the Rules of this system are few, clear, concise and decisive, offering to the mariner all the guidance he may need in any encounter, in clear weather or in restricted visibility using radar, because they meet all the questions that generally arise and in particular those posed by the collision problem.

REFERENCES

[1] García-Frías, J. (1960). Anti-collision radar sectors. This *Journal*, 13, 316.

[2] García-Frías, J. (1965). The sector rule and the collision problem. This *Journal*, 18, 141.

[3] García-Frías, J. (1970). The revision of the rules. This *Journal*, 23, 71.

Distance by Vertical Angle

Charles H. Cotter

SINCE the appearance of the note by Sayers[1] in 1968, followed by the publication of the table by Thompson[2] in 1969, and having myself described the method which was the subject of Sayers' and Thompson's communications, in a work[3] on seamanship in 1962, I have searched for the origin of the method whereby an observer may find his distance off a ship or floating mark by means of a sextant observation of the vertical angle between the visible or sea horizon and the waterline of the ship or mark whose distance off is required.

It is interesting to note that the method is not utilized in Captain Lecky's famous tables[4] which were popular for many decades after their first publication in 1890; and that it does appear in a small, little-known, set of tables[5] by Commander S. H. S. Moxly, R.N., published in 1941.

My search reveals that the original inventor of the method was Captain A. P. Ryder, R.N.[6] Ryder was concerned not so much with the navigational problem *per se* but primarily with the naval gunner's problem of finding the range of an enemy ship with as little delay as possible. The value of the small handbook which he produced for the purpose was recognized by the Lords Commissioners of the Admiralty who purchased the whole of the first edition (1845) and ordered that a copy be placed on board every British man-of-war. In the preface to the second edition (1854) the author recorded, evidently with satisfaction, that his work had proved of '*service to cruizers on the Coast of Africa in chase of Slavers*'.

Ryder referred to his method as the 'Horizon' method, namely '*To observe from the cross-trees, or other convenient place, the angle subtended between the horizon and the enemy's waterline.*' He pointed out, rightly, that the higher the place of observation the less will any error in the observed angle affect the distance. The method was advertised as being suitable not only for Captains of guns on board ship but also for officers commanding fortresses (Gibraltar and Malta being mentioned specifically). In addition to this the distance from a target, a rock, a breaker or discoloured water, may be ascertained by the same method. Ryder also explained how the table he designed to facilitate the method could be used for determining the rising or dipping range of a light of known height.

To find the range of an enemy ship the angle of dip was to be added to the measured vertical angle. The resulting angle in degrees and minutes, and the height of the observer's eye above the sea in feet, are the arguments in Ryder's

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