The proposals are very attractive. Any change which will remove the difference between the actions taken by ships when not in sight of one another and when in sight of one another is to be welcomed. An additional reason for permitting the stand-on ship to take avoiding action earlier is that very fast craft—hovercraft and hydrofoils—now coming into use, will *have* to do so since ships which are much larger and much slower will be unable to avoid them. Some detailed comment follows:

The proposal of assigning responsibility to one party (excepting the end-on case) as at present, but allowing the stand-on ship more freedom of action, seem excellent and desirable.

Rule 22 (Crossing ships, illustrated in Case II). There is a difficulty here. At present the stand-on vessel (ship B, heading north), if in fog, may reason like this: 'Ship A has either observed me, in which case he will presumably alter course to pass under my stern; or he has not observed me, in which case he will presumably keep his course and speed. It would be foolish of me to stand on into a close-quarter situation. I must not alter course to port in case he alters to starboard; if I alter course to starboard it will merely prolong the crossing. I shall therefore reduce speed drastically until I see what course ship A is pursuing.'

Ship B might be held to be breaking the proposed new Rule 22, yet her action would be, I think, entirely seamanlike. She would be committed to an alteration of course to starboard by the new rule: perhaps this would be acceptable.

Perhaps a sentence such as: 'Alterations of course to port are to be avoided' might be added.

Rule 23, I think, should be left unchanged.

Case III and IV Present Rule. Overtaking ships are merely told to keep clear and are not directed to alter course in any particular direction.

Latitude by Maximum Altitude

from J. W. Crosbie

LATITUDE by meridian altitude is one of the commonest position lines used in the Merchant Navy today, and the traditional method of obtaining it is to observe the Sun until it reaches maximum altitude, at which point it is said to *dip*. With the advent of power-driven vessels, however, this method became liable to an error of 5 minutes of arc,[1] and as faster surface craft are developed it is reasonable to assume that the error could be even greater. This is because the rate of change of altitude of a body is related to the observer's speed over the Earth so that the body will *dip* either before or after meridian passage depending on whether the observer is moving towards or away from the geographical position of the Sun.

Modern textbooks on navigation recommend that meridian altitudes be observed at the calculated time of meridian passage,[1,2] which normally presents no problem to the Merchant Naval officer as it is customary for him to find his 'Longitude by Chronometer' before noon. The old method of observing the maximum altitude is, however, still widely used and may be defended on the grounds that its error is limited by the ship's north–south speed, whereas with

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the new method an error in longitude could lead to an error in latitude, especially in high latitudes.

The following is a method of calculating an accurate latitude from the Sun's maximum altitude. It requires no knowledge of longitude but does require the use of a latitude by account. It is in two parts.

Part I consists in finding the local hour angle of the Sun at maximum altitude from the formula[3]

$$h = 15{\cdot}28y(1 \pm x/900)(\tan l \pm \tan d)$$

where

- h is the hour angle expressed in seconds of time.
- l is the latitude by account.
- d is the declination of the Sun.
- x is the east–west component of the ship's speed in knots.
- y is the north–south component of the ship's speed in knots combined with the rate of change in declination in minutes of arc an hour.

The formula, with the use of Inman's tables, reduces to

$$h = E(y \pm xy/900)$$

where E is found from a table giving 15·28 tan latitude or declination. A short and simple table could be constructed to give the quantity $(y \pm xy/900)$, also.

Part II. Since we have calculated the hour angle h, which will always be small, the corresponding latitude can be found by any of the many methods for the reduction of ex-meridian sights, either by direct calculation or by the use of tables. The latitude so found is itself a position line.

REFERENCES

1 *The Admiralty Manual of Navigation*, Vol. II (1960), Chapter XII.
2 Cotter, C. H., *The Elements of Navigation*, Chapter 33.
3 *The Admiralty Manual of Navigation*, Vol. III (1955), p. 142.

Captain C. H. Cotter comments:

It seems that in the Merchant Navy the observation of the Sun at noon for latitude is still regarded as being the pre-eminent sight in the day's work of the nautical astronomer. Moreover, it appears that only the enlightened navigators in this service are aware that the maximum altitude of the Sun is not generally the meridian altitude.

The old-fashioned practice of waiting for the Sun to dip before the order to make eight bells is given is not only time-consuming and unnecessary, but worse than either of these it may lead to unnecessary error (admittedly small in most cases) in the ship's position. If the noon latitude is the factor around which the navigation of the ship revolves there is no excuse for not seeing to it that it is obtained in a correct manner.

Apprentice Crosbie is to be congratulated on his investigation into the interesting problem of latitude by maximum altitude. The formula he quotes for finding the interval between the times of maximum and meridian altitudes dates from the middle of the last century, and tables giving values of 15·28 tan lat (or dec), which were designed originally for the longitude by equal altitude problem, were adapted for finding the interval between the times of maximum and meridian altitudes. It is interesting to note that in the first *Admiralty Manual of Navigation*, which was published in 1914, a critical table giving values of 15·28 tan x is given.

The discussion is full of interest. However I think that, in general, there is no better way of getting nautical astronomical results than by drawing position lines, which have been found using the all-embracing intercept method, on a suitable plotting sheet. The plotting method is rapid, practical and neat, and it helps the navigator to keep in mind the essential principles of position line navigation. More important perhaps than any of these is that by considering the angle of cut between the plotted position lines the navigator is provided with an indication of the degree of accuracy of his final result. The apparent hocus-pocus associated with the finding of the ship's noon position and the computations associated therewith, do not provide the navigator with this useful knowledge.

D. H. Sadler, Superintendent of H.M. Nautical Almanac Office, comments:

The preceding note by Mr. Crosbie is to be welcomed as an indication of modern interest in an old problem. Although a single observation of altitude taken near the time of meridian passage will generally suffice to give the latitude within observational precision, it is not easily possible to combine several 'shots', since the altitude does not vary linearly with time. Thus the maximum altitude may be observed with greater precision, and it is relevant to enquire how best the latitude can be deduced.

Mr. Crosbie rightly draws attention to the curious incompleteness of the treatment of this problem in the *Admiralty Manual of Navigation*, Volume III (1954 edition): whereas the time-interval between meridian passage and maximum altitude is determined with much detail, no reference is made to the correction that should be applied to the observed maximum altitude to give latitude. Mr. Crosbie suggests that the correction be determined from one of the many ex-meridian methods of solution; but a much simpler method can be derived by direct expansion. Using the same notation, the interval t, in seconds, between meridian passage and maximum altitude is

$$t = 15^{s}{\cdot}28y\left(1 + \frac{2x}{900}\right)(\tan l - \tan d)$$

the correction, in minutes of arc, to be applied to (90° ± declination − observed maximum altitude) to give latitude is:

$$\text{correction} = 7'{\cdot}64(y/60)^2\left(1 + \frac{2x}{900}\right)(\tan l - \tan d)$$

which can be evaluated at the same time as t.

It is interesting to observe that, if meridian passage occurs at time t_0, then the maximum altitude is the same as the meridian altitude that would have been observed from the ship's position at time $t_0 + \frac{1}{2}t$. Thus, if no correction is applied to the maximum altitude, the deduced latitude is that of the ship at time $t_0 + \frac{1}{2}t$; the correction is simply one-half of the equivalent motion y.

The appreciation, and solution, of this and similar problems is greatly simplified by reference to tabulations of altitude (and azimuth) such as are given in H.D. 486 (*Tables of Computed Altitude and Azimuth*).