Forum

A Fix by Total Solar Eclipse

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In anticipation of the TOTAL Solar Eclipse on 11 August 1999 (see the January/February issue of *Navigation News*), it seemed very appropriate to repeat this short article by one of the Institute's most respected Fellows. It was first published in Vol. VII, October 1954.

A TOTAL eclipse of the Sun provides an opportunity, rare though it may be, of obtaining an instantaneous fix from the Sun alone. Eclipses vary greatly in character, in position on the Earth, in the width of the path of totality, in the duration, and also in the direction of the path. However, the shadow of the Moon cast by the Sun is always a right circular cone which, in the case of a total eclipse, intersects the Earth's surface at some point before its vertex. Owing to the motion of the Moon in its orbit round the Earth, the shadow moves at a speed of about 2000 m.p.h. from west to east (it varies considerably according to the distance of the Moon from the Earth). The intersection of this cone with the Earth's surface is an ellipse, which moves over the surface at speeds which are very high when the cone is nearly tangential (i.e. when the Sun's altitude is low) and at speeds as low as about 1000 m.p.h., when the eclipse is central over the equator at noon and the Earth's rotation has its maximum effect. The speed of the shadow is generally low enough to give a position line of considerable accuracy from the observed time of either second or third contacts, that is the beginning or ending of the total phase. An error of 1 second corresponds, in the most favourable case, to about one-third of a mile. The position line is, of course, the portion of the elliptic shadow corresponding to the observed phase and time; these can be precomputed.

Limitations of accuracy occur because of the uncertainty of the position of the Moon (actually this is due largely to the unknown variation in the rate of rotation of the Earth itself), the serrated edge of the lunar disk (due to the mountains on the Moon) and the difficulty in timing the contacts. None of the above should give rise to errors of more than say, 2 seconds.

A second position line must be obtained by the conventional method of observing the Sun's altitude shortly before totality; unless very close to the sunrise and sunset limits, this should give a reasonable cut. The duration of totality, even when corrected for the motion of the observer, is insufficiently sensitive except very close to the edges of the path of totality.

An opportunity to use this technique, of such limited application, occurred on 30 June 1954. A Hastings aircraft from the Royal Air Force Flying College at Manby, in the course of a navigational exercise, conveyed a party of astronomers to a point about 100 miles south-west of Reykjavik in Iceland where the track of totality crossed the zone of maximum auroral activity. The flight plan called for the aircraft to be at a particular point at a particular time. Navigation was by purely conventional methods; a visual fix over Keflavik was run on and checked by radio bearings, Consol and Sun sights – the estimate of uncertainty of one mile was by no means an over-estimate. Preparations were made to time the beginning of totality which, however, had no great scientific importance, but there was so much to see and do that no one succeeded in obtaining a reliable time for the second contact. Several observations were made by stopwatch of the duration of totality (nearly 170 seconds, this being 20 seconds longer than that for a stationary observer owing to the ground speed – 208 knots – of the aircraft); and one, not very reliable, observation was made of the time of third contact. This was in accord with the navigator's position, within the limits of the uncertainty given above. No special sight was taken of the Sun's altitude since this would merely have duplicated the navigator's sights; as the eclipse track was practically due west–east the two position lines gave an excellent cut.

As will be seen, there is some excuse for my failure to use this unique navigational opportunity to the full. It was my first eclipse, seen under the most perfect conditions. The shadow rapidly overtaking the aircraft was a thrilling sight, and so was the sudden change from the intense light of the last, rapidly diminishing crescent of the Sun itself, through the momentary glimpse of the photosphere, to the delicate colours of the corona. A most impressive spectacle was the advancing 'sunset' glow on the western horizon, with an orange band at the edge of the shadow. The corona was generally as expected for sunspot minimum, with long extensions in the Sun's equator; the inner corona was, however, extremely bright – almost as bright as the full Moon. No stars were seen, mainly because of the bright corona, but Venus was easily visible. By an incredible coincidence Jupiter was actually 'occulted' by the Sun during the eclipse, and was so invisible. It might be thought that the visibility of stars during a total eclipse would provide alternative means of obtaining a fix; but no one could possibly look elsewhere than at the Sun, unless they were engaged in essential scientific observations.

The flight was admirably planned and executed; great credit is due to all concerned, particularly to the crew from the Royal Air Force Flying College at Manby. They have the satisfaction of knowing that, although the main scientific observations resulted in negative information about the aurora, the large number of measures of the colour of the sky during the partial and total phases have already led to valuable theories of light scattering in the upper atmosphere.

Why is There This Urge to Pass 'Close To'?

A. T. C. Millns

One of the first occasions that navigators became aware of the potential problem generated by the (then) recently-invented radar, was the so-called *radar-assisted collision* which occurred outside of New York between the *Stockholm* and the *Andrea Doria* in 1956. Forty-seven lives were lost in the *Andrea Doria* and five on the *Stockholm*.

Radar (Radio Detection And Range) had been invented and began its sea service during the Second World War. Its use had been, as its name implied, to give initial warning of, and the range of, another vessel on a simple Cathode Ray Tube. As the system was enhanced and the Plan Position Indicator (PPI) style of display came into prominence, complete stretches of the coastline were shown. Its usage was enhanced so that ships began to be navigated by radar. However, the navigator himself was still very much in touch with the natural elements, through the very open design of the bridge at that time.

Following the *Stockholm*/*Andrea Doria* tragedy, navigators came to terms with the fact that their PPI view of the world was a relative one rather than the actual world. Plotting the observations became the norm.

As the navigation of vessels became more electronic and reliance on various navigational aids became the norm, the actual situation has again become obscured by the relative/calculated. We became used to virtual reality, keyhole surgery, missions to space and all manner of science in our living rooms. Our cars have become cocoons, as they hurtle along the motorway, dare I say, in fog and heavy rain. However, despite air-conditioned bridges, the sea is still a harsh environment, and marine equipment continues to fail when least expected. It is not that long ago that I had to take one of the Union Castle Mail Ships up the coast between East London and Durban on a magnetic compass, with a seaman in the chains feeling for the 100 fathom line, oil sidelights etc, all due to a complete power failure to the bridge. Engines failed to start on cue for the *Maria Asumpta* on the Cornish Coast, for the *Eendracht* in the

English Channel and for the *Woody Goose* on the coast of New Zealand, each event ending up in a grounding or worse.

We now have the situation where the Master/OOW is fearful of switching off the radar/VHF, and these items have thus become the SOURCE of navigation rather than an AID to navigation. Calculations are made to check if a vessel will pass clear, or a VHF call is radiated to enquire of the other ship's intentions. (These calls have been known to be answered by the *wrong ship*!) Whilst English is still the language of the sea, some do not have a full command of it; indeed, multi-national crews can suffer from internal communication problems.

Calculating that a vessel will pass five cables to port in the open sea, is a nonsense. It may be correct in theory but, in practice, it is no distance at all, since it makes no allowance for any error or malfunction. A 5 or 10 degree turn will not be picked up quickly, if at all, by the approaching vessel's navigator. In the past, when radar was recognised and used as ONLY AN AID, it was instilled in traditional navigators that a 30 or 40 degree turn was made in order that it was quickly seen and understood by the approaching navigator.

I have listened to several learned presentations on calculating the exact angle of alteration that is required using several different formulae, but each one appears to rely on the fact that the other vessel will also make way in a close quarters situation (i.e. the blame will be spread), and no-one has come up with a simple answer as to why it is necessary to get into a close-quarters situation in the open sea in the first place. I have also listened to assessors apportioning the blame. Time and time again it would appear that if the OOW had simply used his eyes – rather than simply using his radar – and made a bold alteration to start with, the other vessel would have simply been a passing vessel rather than ending up as another statistic. The fact of gyro, steering or personal malfunction appears to be no longer considered or built into any response action taken. It is assumed that five cables is exactly five cables without a shadow of doubt, and it is reported that High Speed Vessel navigators operate with a 20 metre passing distance, as though the sea were a highway with tram tracks concealed beneath its surface, and even that some liner officers delight in passing close.

Much of this, I am sure, is against a background of nations appointing Masters after only some three years at sea. Even at the reciprocal passing of the Mail Ships, which were well coordinated, our distance was still at least a mile apart with watertight doors closed and an experienced quartermaster on the wheel. In particular on this type of ship, I was very aware of passing vessels who edged over in order to view the passengers lunching on deck, or the sunbathers by the pool. My alterations were thus more positive to avoid any close-quarters situation.

Somehow the navigator has to realise that he must re-learn his ancient skills, and use them in conjunction with modern aids, but not instead of them. Instrument manufacturers, and their salesmen, have very realistic displays where one can be on a 'bridge' situated in reality miles from the sea, complete with electronic charts, the lot. This may well lead to the nautical equivalent of 'Motorway Madness'. One hears of the amusing story of the purchaser of a large motor yacht whose friend programmed his GPS for the voyage from the Solent to the Channel Islands, but forgot to tell him how to return!

Whilst I am all for progress, there is still more to seamanship than reading numbers off a dial. The reason that these instruments are but AIDS TO NAVIGATION must continue to be instilled until it is second nature. *Action has to be seen to be taken, must be positive and in good time*. The Ocean is still not a place for keyhole surgery, with instruments many hundred feet long and of relatively poor response.

My *Blue Funnel* experience – whose practice was to pass 20 miles off a headland, when others passed 10 miles off – proved to me that we could keep regular competitive schedules around the world without being penalised for this practice. In fact, with a fleet of over eighty ships, that Company lost only one ship (outside of war service) in a hundred years of operation and that was due to an engine room fire.

There are no medals for passing CLOSE TO in the open sea.

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KEY WORDS

1. Seamanship. 2. Colregs. 3. Accidents.