

FORUM

Modern Nautical Tables

IN the last number of the *Journal* (9, 444), the substance of a memorandum from H.M.S. *Dryad*, the Admiralty Navigation School, was published listing the tables which the Royal Navy would wish to see included in any set of nautical tables published for general use. The Institute has been invited to advise the Admiralty on the composition of any set of nautical tables compiled for use by both the Royal Navy and Merchant Navy. Meanwhile, and as a useful guide to the Institute working party which will consider this problem, Members have been invited to comment on the list proposed by H.M.S. *Dryad*. Selections from the comment received are given below.

from C. H. Cotter

A compiler of nautical tables in deciding what tables to include in his selection must direct his attention, in general, along one of two lines. Either he must consider current practice and supply a collection of tables which he knows will satisfy prospective users, or he must consider what he himself thinks *should* be the current practice and supply tables accordingly. It appears that most compilers in the past have worked along the lines of the first alternative, and this has been partly responsible for the perpetuation of archaic methods, and also for the extraordinary number of tables—many of which are quite superfluous—to be found in current navigation tables.

It is well known that seamen as a body are conservative in the extreme. Their inherent dislike for changes, even beneficial changes, was manifested for example by the general disapprobation of practical navigators to the introduction of what is now generally acclaimed to be a very fine nautical almanac. Their desire to retain that which they consider to have stood the test of time is evident by the popularity of some of the well-known current sets of tables which have run through numerous editions. If therefore, the second alternative referred to in the opening paragraph is chosen, the risk as to whether a compiler's tables will find a ready market will be great.

My personal selection (not having to consider a market), would be based on what I think a navigator ought to have, which of course would most certainly not be what many navigators would want.

First, allow me to comment on the list of tables considered essential for use by the Royal Navy. I am sure that such a list will provoke much discussion among Merchant Navy navigators. To my mind several of the tables included in the list are of no use whatever to the practical navigator. On the other hand, some tables which I, and many other navigators I am sure, would consider essential, have been omitted. Those which could very well be left out of the list are:

Dip of the Shore Horizon
Dip of the Sea Horizon
Departure into D. Long.
Mean to Middle Latitude
Amplitudes

Equal-altitude Tables
Masthead Angles
10-ft. Rod Tables
Half-log Haversines
Reduction of Latitude

Some of these, viz. dip of the shore horizon, equal altitude tables and reduction of latitude, are of academic interest only. The dip of the sea horizon table, like tables of refraction, semi-diameters and parallaxes, need not be included, suitable altitude correction tables being included in the *Abridged Nautical Almanac*. A table of masthead angles is of little or no use to a Merchant Navy navigator, and why the 10-ft. rod table has been included as an essential table is beyond my comprehension. The use of amplitude tables often leads to error in compass deviations, as so many so-called amplitude observations are made when the observed object is nowhere near the celestial horizon. Especially is this the case in high latitudes. The use of amplitude tables to my mind should be discontinued and recourse made to suitable azimuth tables. The departure into D. long. table is superfluous if a traverse table is at hand, and the mean to middle latitude table is unnecessary if a table of meridional parts is available. Lastly, half-log haversines are not generally used in the Merchant Navy—natural and log haversines are used instead.

My hypothetical book of tables would include the following:

1. Traverse Table
2. Logarithms of Numbers
3. Trigonometrical Functions (sines, cosecants, tangents, cotangents, secants and cosines)
4. Logarithmic Trig. Functions
5. Natural and Logarithmic Haversines
6. Meridional Parts
7. Distance off by Vertical Sextant Angle
8. Distance of Sea Horizon for finding range of dipping or rising light
9. Log. Steaming Times from 23.00 to 25.00 hours

Tables 8 and 9 I would have printed on the inside covers. Tables 1 and 5 I would have placed at the beginning and end of the collection, these positions being the optimum ones for accessibility.

Many navigators would doubtless be aghast at not seeing the ABC tables included in the above list. These tables are very popular with Merchant Navy navigators. This is chiefly because the normal practice on merchant ships is to solve an a.m. Sun sight by means of the restricted longitude method, and to use the ABC tables to find the 'longitude correction', which is the name given to the error in minutes in a calculated longitude for each minute of D. lat. between the true latitude at the time of the observation and the latitude used in the calculation. The longitude correction facilitates the finding of the longitude at noon, after the latitude by meridian altitude observation has been found. Throughout the process of finding the noon position by this method, the notion of position-line navigation, which is the essence of the problem, is more often than not entirely ignored. The position is found as if by white magic.

Personally I would like to see all but one of the methods of calculating position lines, parcelled up neatly, weighted and sewn in canvas, and hove overboard in deep water. The exception of course is the supreme, all-embracing intercept method, used in conjunction with a plotting sheet: the direction of the position line being found from Burdwood's altitude-azimuth tables. These tables are useful not only for finding azimuths, but also for determining great-circle courses and distances and also for star identification.

Convergency corrections for great-circle bearings may be found with the

greatest of ease by means of the traverse table—a separate table of corrections is therefore unnecessary.

My requirements for practical navigation would be a book containing the nine tables enumerated; a set of Burdwood's altitude-azimuth tables; a modern short method table such as Myerscough's and Hamilton's *Rapid Navigation Tables* (which includes a neat little ex-meridian table); and a plotting sheet. With these I would be perfectly happy.

from Ronald Turner

1. If all sights are to be worked out by rapid reduction tables, then surely it is not necessary to retain the trigonometrical tables.
2. If it is considered necessary to retain the trigonometrical tables to cope with an occasional sight, then the ABC table and the ex-meridian table should also be included.
3. Most ships are supplied with azimuth tables, therefore the ABC and amplitude tables may not be necessary.
4. The half-log hav. formula and the equal-altitude formula are rarely used in the Merchant Navy.
5. Departure—D. long. table is unnecessary if a traverse table is included.
6. No traverse table is required if the navigator knows the simple use of a slide rule.
7. Dip of shore horizon and dip and distance of sea horizon are small tables whose inclusion will make little difference to the size of the nautical tables.
8. Masthead angles and 10-ft. rod tables are not used in the Merchant Navy.

If the navigator is armed with short method tables, Nautical Almanac, slide rule and possibly a Weir's azimuth diagram, the only indispensable part of the nautical tables as they stand at present, is the table of meridional parts.

In Merchant Navy schools, navigators are taught basic methods of navigation, where principles are amply demonstrated, and because they come to know these methods well, navigators tend to stick to them. Any adoption of short methods only comes about from the interest of the individual navigator. Every navigator possesses a set of nautical tables, because these are required for examination purposes. If a navigator wishes to use short method tables, the expense of buying the tables is his; they are not part of a ship's equipment. Some of the short method tables are also bulky and heavy to carry around from ship to ship. Therefore in the Merchant Navy the general tendency is still to make full use of existing nautical tables; only the person who is really interested in navigation will bother to equip himself with the short method tables.

Many people feel that as they are on watch for 4 hours anyway, it makes little difference if a star fix takes 10 or 40 minutes to work out. I have been an enthusiastic user of A.P. 3270 Vol. 1 since it was first published, but despite the demonstrable speed and accuracy obtainable with it, I have found that fellow navigators continue to stick to their old methods for the reasons I have mentioned.

I think the majority of Merchant Navy navigators will continue to require a full set of nautical tables and only the really enthusiastic navigator will find them redundant.

from P. C. H. Clissold

One is inevitably biased in favour of methods and tables to which one has become accustomed, but, speaking as a navigator of (principally) merchant ships, and one who has turned from Inman to Norie, and from Norie to Burton, I should like—if I had examinations in prospect—the latest edition of Burton's Tables. Without the consideration of examinations I know I should never need the 17 pages of natural functions of the angle, though I would keep the one page of natural functions to whole degrees.

From the 'essential' tables listed in *Dryad's* memorandum I would omit tables 4, 8, 9, 10, 16, 17, 18, 19 and I should certainly include the vertical off-shore distance tables and the conversion table of kilometres, &c.

The remarks about the cost and bulk of nautical tables apply with particular force to the non-professional navigator of a small craft. His interest in navigation may be purely practical and he will not necessarily have any knowledge of trigonometry or logarithms, or the desire to acquire it. Vice-Admiral A. Day, in his Presidential Address in January 1954, said 'It would seem that anyone who takes a sight should be able to draw the spherical triangle he uses without having to rack his brains unduly and *without necessarily learning the spherical trigonometry employed in its solution.*' I think the following tables would be adequate for all small ship requirements:

SMALL SHIP TABLES

Table	<i>Coasting Tables</i>	No. of pages
1. Speed, Distance and Timetable (for intervals of up to one hour)		1
2. Rising and Dipping Distances		1
3. Vertical Sextant Angles, Distance by,		4
4. Tacking Table (distance to regain course line; made good, &c.)		1
5. Dutchman's Log (speed by)		1
6. D.f. (Great-circle conversion to Mercator bearings)		1
7. Running Fix Factors		2
	<i>Ocean Navigation</i>	
8. Traverse Tables		90
9. Amplitudes		2
10. Total Altitude corrections for Sun		1
11. Total Altitude corrections for Star		1
12. Total Altitude corrections for Moon		2
13. Total Altitude corrections for Bubble Sextant		1
14. Altitude-Azimuth Tables		90
15. Ex-meridian Altitude Table		2
Miscellaneous (Metres to fathoms, &c.)		1
Blank pages for notes, &c. (one edge printed with Table Titles for cutting out and sticking on as tabs for marking).		
16. Tables of Compass angles (points and 0° to 360°)		1
	Approx. total pages	200

Notes

1. *Altitude-Azimuth Tables.* A mixed-method table was chosen because of its great compactness and world-wide application, though for a limited range of

latitude HO 214 might be preferred. The mixed-method tables compared were Myerscough and Hamilton, Dreisonstok, Aquino, Lieuwen, Ogura and those published by Hughes. Myerscough and Hamilton was selected as being the best laid-out and easiest for use in difficult conditions at sea. It has also been described in the review of the new edition (*Journal*, 3, 313) as 'much the best book yet produced of this assumed position type', and in a review of 'Little Ship Navigation' (*Journal*, 6, 108) the reviewer says Myerscough and Hamilton 'might have been recommended as an alternative to HO 214 because of its compactness'.

2. *Traverse Table*. It will seem that the only other large table is the ordinary traverse table. With this all 'sailing' problems can be worked out with sufficient accuracy. It is immaterial whether a distant port is 1005 or 1015 miles away if one is unlikely to proceed there on a perfectly direct line. Great-circle courses can be found by the altitude-azimuth tables.

3. *Altitude Correction Tables*. Yachtsmen may often use Reed's or Brown's Nautical Almanac instead of the *Abridged Nautical Almanac* because of the great deal of other information contained in the former two books. Though both these have altitude correction tables they are not so clearly and boldly printed as they could be in a non-annual publication; so these tables have been included.

from Captain F. N. Hopkins

(Technical Adviser to *Norie's Nautical Tables*)

1. The tables listed on page 444 of the October *Journal* should properly be described as navigation tables, not nautical tables. The latter term more appropriately applies to a set of tables considerably wider in scope than a set of exclusively navigation tables. *Norie's* includes some ten tables which, although considered to be of value to Merchant Navy officers, are not navigation tables. *Norie's* is intended to be, and in fact is, a set of *nautical* tables in the proper sense of the term.

2. With regard to navigation tables as such, the vast majority of Merchant Navy navigators are not likely to be interested in:

- Equal-altitude Tables
- Tables of Masthead Angles
- 10-ft. Rod Tables
- Half-log Haversines
- Figure of the Earth (reduction of latitude)

3. The writer from H.M.S. *Dryad* mentions that for R.N. purposes only about one third of the tables appearing in *Norie's* and certain other similar publications are used in the R.N. He does not, however, make it clear which edition of *Norie's* he is referring to. He may not be aware that the 1956 edition is substantially different from earlier ones. Even so, it is not surprising that much of the contents of *Norie's* will be superfluous to the requirements of the R.N. Whereas the Admiralty issue their own sight reduction tables to H.M. ships, it is not, as far as I am aware, the custom of private shipowners to supply such tables to merchant ships. Each individual M.N. navigator obtains his own tables and, naturally, chooses those he thinks best suited to his individual needs. For the benefit of those navigators who are interested in short methods of sight reduction

—and there is some reason to think their number is increasing—the new Norie's contains an altitude–azimuth table as well as altitude adjustment tables that can be used in conjunction with the former.

4. It is also stated that the present-day cost of Norie's and other tables 'is by no means negligible'. The writer must know that printing and publishing costs of all kinds, like other costs, have risen steeply during the last few years, but it is only fair to point out that inflated wages and salaries have more or less kept pace with inflated prices. If one considers the life of a set of tables to be ten years—a reasonably conservative estimate—Norie's will cost its owner a little more than three shillings a year, which seems to be pretty good value for money.

5. Reducing the size of a book of tables merely in order to take up less space in the chartroom bookshelf would scarcely appeal to the average M.N. officer as a sound proposition. Habits may have changed since I was at sea, but I seem to remember that we never made a practice of keeping our tables in the chartroom bookshelf. A more usual custom was to keep them in a convenient place on the bridge while at sea, together with one's sextant, and remove them to one's cabin while in port. Where this was not convenient one carried them up and down each watch. In any case a ship is not an aeroplane, and the chartroom of a modern ship of any size is not so cramped as all that. Norie's policy is to give the Merchant Navy officer what he appears to need. When convinced that a particular table has outlived its usefulness, Norie's will cease to include it. Equally, when a new table is sufficiently demanded Norie's will supply it.

6. It is true that the inclusion of altitude correction tables in the *Abridged Nautical Almanac* has rendered it unnecessary to put them in a set of tables designed for R.N. use. However, there is still a significant number of British merchant ships whose officers do not use the official nautical almanac. For reasons best known to themselves they seem to prefer to use the privately published nautical almanacs like Reed's and Brown's—probably because those publications contain a large amount of other information useful to the persons concerned in the particular trades in which they are employed—tide tables, distance tables and so forth. Another important factor is that Norie's is used not only in British ships but in a fair number of foreign ships as well. It is more than likely that many of these foreign users do not have nautical almanacs giving altitude correction tables. For these reasons it is necessary that Norie's should continue to supply such tables.

7. I doubt very much indeed that there ever could be 'general broad agreement' either on the list of tables the writer from H.M.S. *Dryad* has submitted or, for that matter, on any other list. It remains a fact that one man's meat is another man's poison. Norie's have frequently, and over a long period of time, had requests for a set of 'only those tables which are in every-day use at sea'. It is very far from being a simple matter to decide which tables should be included in, or excluded from, such a set. With regard to the present Norie's, for instance, if a navigator decides to use the altitude–azimuth table for sight working he will use it 'every day'. If he decides otherwise he will not use it at all. The same argument applies to certain other tables—they are either in every-day use, or they are totally ignored. To suit all tastes it would be necessary to publish a very wide variety of 'tables in every day use at sea'—which is obviously impossible. Some years ago, before the second world war, Norie's did in fact produce an abridged edition of their tables in response to a number of requests

for a severely limited and practical book of tables. The actual demand for these turned out to be so disappointing that their publication had to cease.

No doubt it would be very neat, tidy, and regimental if all navigators in all types of ships somehow or another reached agreement that they would in future all use precisely the same tables, the same almanac, and the same methods and techniques; but one feels that it will be a very long time before this comes to pass. I, for one, have no regrets that I shall not live to see the day. Variety is the spice of life.

The Accuracy of Dead Reckoning in the Air

from Captain E. D. Maya

(Transportes Aéreos Portugueses)

1. INTRODUCTION. We have followed what has been written in this *Journal* about the accuracy of dead reckoning in the air and the determination and use of the most probable position. We wish to refer in particular to the article by J. B. Parker entitled 'The navigational implications of Mr. Durst's paper' (this *Journal*, 8, 113). We are not familiar with the routes of the North Atlantic or Central Africa; we have, however, eight years experience on the routes Lisbon–Luanda–Lourenço Marques, via Dakar, as well as those overflying the Sahara Desert via Oujda and via Agadir. The following considerations are in great part the result of that experience.

2. ACCURACY OF DEAD RECKONING. It seems to us extremely difficult to apply in practice the statistical concept of a D.R. error with the object of its application to the routine work of navigation in flight and thereby contribute to the safety of the operation.

Taking now into account only the error due to the forecast meteorological wind, the assertion can be made at once that the linear error in the D.R. position per hour is not greater than the sum of the strength of the max. wind existing in the area, with the strength of the wind used to calculate the course to steer. This observation, though self-evident, appears to us to have a somewhat deeper meaning than would appear at first sight.

Our experience, using DC₃, DC₄ and Super Constellation aircraft on the aforementioned routes, especially on those overflying the Sahara Desert, shows us that there are regions where the winds are definitely more constant, not very strong, and more in accordance with those foreseen by the Met. services; and others where a surprise is always to be expected, as the winds are there more irregular, generally stronger, and sometimes much more at variance with those that had been forecast.

To increase the preoccupations of the navigator and the captain of the aircraft, precisely in the regions where these last conditions occur, terrain clearance problems exist to such an extent that safety of the flight may be impaired should the route be flown by aircraft with no pressurized cabin. As we think that this subject is an interesting one, we proceed to discuss each one of those regions.