METHOD OF COMPUTING HYPERBOLIC LATTICES ON CHARTS WITH THE "DECCA NAVIGATOR"

Extract from *International News Letter* No. 2, January 1947 issued by the "Marine Safety Division", Ministry of Transport, LONDON

The Hydrographer of the Royal British Navy has prepared the following note on the method of computing hyperbolic lattices on charts for use with the Decca Navigator. A more comprehensive description of the technique of computation used in His Majesty's Nautical Almanac Office is under preparation, together with examples, and copies will be available in due course.

Initial information required.

1. Accurate geographical positions of the transmitters (these positions should be checked from the rectangular coordinates obtained in the survey and adjusted, as necessary, for systematic difference in origin, if referred to different triangulations).
2. Frequencies of the transmissions, and comparison frequencies.
3. Velocity of propagation.
4. Area to be latticed.
5. Scale of the charts to be latticed.
6. Figure of the Earth used in the construction of the charts and in sympathy with the positions used in 1.

Notation.

φ = latitude.
λ = longitude.
a = major axis of Earth.
c = minor axis of Earth.
u = reduced latitude.
υ = frequency of transmission.
v = velocity of propagation.
h = chord distance between two points of the Earth.
s = corresponding arc distance.
$\Delta h = s - h$.
l = lane number.
k = number of lanes per unit of length.
t = coding constant.

Suffixes are attached to these quantities to indicate to which points or stations they refer.

Formulae.

1. The reduced latitude is given by :—

$$\tan u = \frac{c}{a} \tan \varphi$$

2. The chord distance between two points P_1 and P_2 is found from :—

$$h^2 = a^2 (\cos u_1 - \cos u_2)^2 + c^2 (\sin u_1 - \sin u_2)^2 + 2a^2 \cos u_1 \cos u_2 (1 - \cos (\lambda_1 - \lambda_2))$$

3. The chord distance h is converted to arc distance s by means of

$$s = h + \Delta h$$

where

$$\Delta h = \frac{h^3}{24R^2} + \frac{3h^5}{640R^4} + \dots$$

in which R is the geometric mean of the two radii of curvature of the normal arcs at each end of the arc. For this purpose R may, however, be treated as a constant varying slightly with latitude and with azimuth of the arc; the error arising from the use of such an approximation will not be appreciable for distances up to 300 miles and the formula can generally be used with adequate accuracy for much larger distances.

4. The lane numbers are found from :—

$$l = k\,(t + s_1 - s_2)$$

where $k = \upsilon / v$ = number of lanes per unit length, and t is a constant depending on the method of numbering the lanes. If in the chain AB it is decided to number the lanes so as to commence with zero at A, then

$$t_{AB} = AB$$ i.e. the distance between A and B,

if, in the chain AC, it is decided to commence numbering with N at A, then

$$t_{AC} = AC + N/k_{AC}.$$

Brief description of the Calculation.

1. A Station Data Sheet is computed in order to determine the distances between the stations and the constants k and t. This sheet must be completely, and independently checked beyond the possibility of error, before proceeding to routine computation.

2. A series of points, equally spaced in latitude and longitude, is chosen to cover (with an overlap) the whole area to be latticed. The distance from each of these points to each of the stations is computed and these distances are combined to form the lane numbers at each of the selected points. The lane numbers are interpolated inversely to give the coordinates of convenient multiples of integral lanes and these coordinates are directly interpolated to give the coordinates required for plotting.