NOTE ON USE OF RAYDIST SYSTEMS IN BRAZILIAN HYDROGRAPHY

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RAYDIST TYPE ER, MODEL II

Model II results from improvements to Model I *, due in large part to experience acquired with this equipment in surveying the North Bar of the Amazon and reported to the Hastings Instrument Company, Hampton, Virginia.

Improvements to Model I

The most significant difference between the two models consists in the 400-cycle beat signal sent out by the fixed stations — in Model I frequency modulation transmission was used, but this has been changed to amplitude modulation in Model II. This increases the number of units at the fixed stations, and lengthens the range for a same output power of 100 watts. As a consequence of the new transmission system, the dimensions of the mobile station units have been slightly increased owing to the replacement of the frequency-modulated receivers by amplitude-modulated receivers, and to the use of a double receiver for the mobile station beat, in which the continuous-wave signals from the circular station as well as the 2F continuous-wave signals from the transmitter itself are received.

At the fixed stations, the antenna equipment for Model II are 100-foot masts divided into 10-foot sections and each equipped with its ground plate, thus requiring a larger surface for positioning. During the Banco Volage expedition, only 60-foot masts could be used, without detriment to performance. During the survey from S. Marta to Torres, 70-foot aerials were used, with a resulting maximum range of 104 nautical miles.

There is no difference in the method of using either ER model.

(*) See article by same author which appeared in the *International Hydrographic Review*, Vol. XXXIII, No. 2, Nov. 1956, page 67.

RAYDIST TYPE DM

This is the new type of Raydist installed on our survey ships being built in Japan, and is the outcome of improvements incorporated in Raydist ER, Model II, by using the circular and elliptic combinations of the system. The indicators supply the following two readings directly :

R_1 : the distance in lanes to the fixed circular station;

R_2 : the distance in lanes to the hyperbolic station.

The distance to the circular station is determined by comparing the signals of receivers R_1 and R_3 at the mobile station, which respectively indicate the signal from the circular station and the beat of the shipborne station.

The novelty consists in determining R_2 by means of an elliptic solution, the following equation being solved mechanically and electrically in the indicator :

$$R_2 = B + 2E - R_1$$

The R_1 and R_2 values are displayed in the indicators, which in contrast to models I and II are totalizers and supply the figures for such values. This reduces the work of the recorder, no longer compelled to work out the value of R_2. The sounding team may hence be reduced by one man.

Raydist DM is moreover smaller and lighter than Model II, although the electronic system is more complex and the equipment more delicate owing to the use of transistors. This requires more highly trained personnel for the operation and repairing of the equipment, as a natural consequence of the increased range and greater economy of use in sounding operations.

ACCURACY OF RAYDIST SYSTEMS

The indicator dials of either type of Raydist supply a reading accuracy of one-hundredth of a lane, depending on the 2F frequency used in the mobile transmitter. So far we have used a frequency of 4 127 kc/s, the lane width thus amounting to 36 306 m.

As our sounding sheets were only on the scale of 1/25 000 and 1/50 000, this lane width value is eminently satisfactory, and the accuracy of measurements is higher than that actually required. The accuracy of measurements hence depends on the intersection of circles of position or distance circles. Although in theory a good fix requires an angle of cut between 30° and 150°, under certain conditions we have obtained reliable fixes with 10° intersections.

Reading errors must be considered as variously affecting the two distance circles : thus an error of one lane in the circular part is reproduced in actual extent on the distance circle related to the hyperbolic station, whereas an error of one lane in the hyperbolic part does not affect the distance circle of the circular station, but is reflected twofold with the opposite sign on the distance circle of the hyperbolic station.

In projecting sounding station positions for a specified area, we now use a method which consists in plotting on the sheet for the area two circles passing through the base line and subtending it by 20°- and 160°-

angles respectively. The figure thus formed is a crescent covering the best positioning area, or area of best intersection of the distance circles. The ship should only sound within this area whenever possible; in other areas the subtense method should be used. Should this be impossible, the stations should be moved to other triangulation points enabling accurate fixes to be obtained in the area to be charted.

So far we have only used Raydist as a control for soundings and have not attempted its application as a control for sweeping. However, the equipment could easily be used for this purpose, provided the area to be swept be well marked, with high accuracy.

The range of the frequency-modulated equipment is limited by the height of the fixed stations, due allowance being made for the fact that the shipborne antennas normally are no higher than the ship's mast. At minimum fixed station height, 30- to 50-mile ranges may be expected for a 15-metre height of the mobile station antennas.

With our ER model II equipment, we recently obtained a range of 105 miles, for a fixed station height of approximately 80 metres. Recent reports of the Hastings Instrument Co. claim a range of about 150 miles for the DM type, for a minimum height above sea level of the fixed stations. These latter two instruments use amplitude modulation for the return signal from the two fixed stations.

These values may, however, not be constant for the same 100-watt output power, depending on ground conductivity at the fixed stations, the ship's electric plant, instrument efficiency, and on the more or less favourable conditions governing radio transmission.

RESULTS EXPECTED FROM RAYDIST EQUIPMENT

With this equipment, a new phase of important sea activity has begun for the Directorate of Hydrography and Navigation. Work can now be carried out without regard to visibility, and, owing to the range acquired, soundings may be made with greater accuracy in areas which otherwise could only be sounded with the help of astronomical fixes, i.e. with the accuracy obtained by mariners along our coast, where we do not yet have Loran or Decca.

There are several sections of our coast where Raydist will be invaluable, owing to the existence of shoals, reefs and rocks out of sight of shore. Among these may be mentioned Abrolhos reef, the banks of the Albardão coast, the shoals off Cabo de São Tomé, the 6-metre-deep shoal off Santa Marta, the entire northeast coast, the area near Salinas, etc.

It is hoped that the commissioning of five brand-new, specially designed survey vessels, equipped with Raydist and other modern improvements, will enable us to operate with greater efficiency and speed up our surveys, since a little less than one third of our coast is covered by new charts plotted by modern sounding methods.