

SONIC SOUNDINGS

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In modern times the exploration and mapping of the land areas of the world have progressed so far that today there are few places left unmapped. As to the depths of the ocean, however, the age of discovery has just started since only recently has the unlimited-depth echo sounder become standard equipment on ocean-going vessels. The echo sounder with its automatic recorder is not yet the perfect instrument for charting the ocean floor, since the depths which the graphical recorder will indicate are limited, but we may be confident that this deficiency will be remedied before very long.

Charting the ocean deeps is of great interest and importance in many fields of science, of course, but its chief value to the Hydrographic Office lies in its utility in the preparation of more accurate and complete charts for the use of the vessels of the Navy and the Merchant Marine. Some may wonder why the charting of depths of the sea greater than 100 fathoms can be of more than casual worth to the navigator; the reason is that modern electronic sounding and ranging equipment makes the profile of the floor of the sea the most universally accessible of the aids to navigation. With the availability of accurate charts, piloting by the prominent features of the bottom may become as usual as coastal piloting.

For the reasons cited, the Hydrographic Office desires and requests that every ship of the Navy and Merchant Marine cooperate in its program, by recording and reporting oceanic soundings on every occasion on which it puts to sea. This guide is designed to assist mariners in the preparation of these reports so that they will require the least disruption of the ship's routine and yet be of maximum utility to the Hydrographic Office for the preparation of reliable charts.

I.—WHERE SOUNDINGS ARE NEEDED

For the most part, the coastal waters of the civilized countries of the world have been surveyed by professional hydrographic vessels with a high degree of accuracy and completeness. These well-surveyed areas usually extend to the limit of visibility off the coast. When operating between well-charted ports, therefore, soundings should be started just before the land is lost from sight and continued until final landfall is made. For operations in poorly charted waters, however, it is better to sound continuously, regardless of depth and distance from land.

II.—THE SHIP'S TRACK

The Hydrographic Office prefers that soundings in open ocean areas be shown and reported on H. O. 3000 Series Plotting Charts (figure 1). These charts, available for issue to ships, are on a scale of 4 inches (2 inches in high latitudes) equals 1 degree of longitude, which is suitable both for ocean navigation plotting and for the compilation of ocean soundings. The *corrected* ship's track, navigational data and notes, and soundings, should be plotted on these charts for the report. The entries may be made in pencil, but legibility and accuracy should be stressed.

In confined waters, such as the Mediterranean, Baltic, North, and Carribbean Seas, it is preferable to plot the track and other data on a regular navigation chart. When the chart used for navigation cannot be spared, the track and soundings may be copied onto a transparent overlay, and this sheet forwarded with the sounding report.

For chart-making purposes, the positions of the soundings are, of course, as important to know accurately as refinements in measurements of the depths. Precise celestial fixes, however, being dependent on visibility, are not always possible, so that the navigator should make all possible use of the available electronic aids. The northern areas of the Atlantic and Pacific Oceans now have fairly reliable loran coverage. Although loran fixes are probably no more accurate than good stellar fixes, the former have the advantage in that the ship's

position can be determined as often as desirable, while stellar fixes are restricted to mornings and evenings during good visibility. When hourly loran positions are plotted on the track chart, at the end of the day the navigator, knowing the speed and course of the ship, can determine and plot the most probable path of the ship for the day. It is on this *corrected* track that the soundings should be entered at an interval of about one quarter inch.

The Hydrographic Office must depend completely on the cooperation of Navy and Merchant Marine vessels to implement this program; the cooperation will be repaid in the form of more complete and useful charts.

III.—THE ECHO SOUNDER

Unlimited-depth echo sounding equipment is standard on many merchant vessels and is also supplied to most ships of the Navy by the Bureau of Ships. This apparatus is subject to serious error unless the operator has a clear understanding of the operating characteristics and limitations of the machine. The manufacturer's instruction manual generally provides a very detailed description and recommends routine checks for the non-technical operator. These routine checks should be made as often as possible, and without fail at every change of watch. The following is a partial list of the most common errors and difficulties encountered in echo sounding:

(A) *No Return*.—When echo sounders in perfect operating condition fail to get soundings the cause is generally aeration of the water which occurs when a ship is steaming in column or backing, or rolling, or pitching in heavy sea. It may also be due to an abnormal quantity of suspended matter in the water as in certain parts of the Gulf of Mexico, where echo sounding is practically impossible due to the heavy concentration of what is believed to be marine life.

(B) *Improper Speed of the Recorder*.—The accuracy of the soundings is directly dependent on the r.p.m. of the motor driving the depth indicator, just as the accuracy of a clock is dependent on the *rate* of revolution of the hands indicating the time. In the case of most deep-sounding equipment, the depth indicator is driven by a synchronous motor depending on 60-cycle current supply obtained directly from the ship's supply. If the ship's supply varies from 60 cycles, the soundings will be in error by an amount proportional to the variation from this standard. If the ship's supply is 61 cycles for instance, the error in a 2,000-fathom sounding is about 33 fathoms.

The operation manual supplied with the equipment suggests an easy check on the speed of the recorder motor to be made on each watch. It is suggested that this check be made as frequently as practical when the ship is recording soundings, and, in addition, the Chief Engineer should be fully informed of the necessity for constant 60-cycle supply. If, in the opinion of the Chief Engineer, the ship's electrical installation is such that this exact frequency cannot be maintained at all times, the necessary steps to provide a reliable supply should be taken.

(C) *Velocity of Sound*.—It is frequently contended that there is little need for refinement in the operation of the echo sounder, since the true velocity of sound in sea water is so variable. However, the velocity of 4,800 feet per second, is in the nature of a datum or standard. It is always possible, for bathymetric and other scientific purposes, to convert soundings to true depths by applying a correction based on the known salinity, temperature, and pressure of the water when the soundings were taken. Data for these corrections are constantly being recorded in connection with oceanographic observations. It is the policy of the Hydrographic Office to chart all deep soundings based on a velocity of 4,800 feet per second, and not correct these soundings except when required to do so for scientific purposes. This policy has the advantage for the navigator in that soundings, as they are shown on the chart, will be in agreement with the observed sonic soundings.

(D) *Multiple returns*.—When sounding over an area of bottom favorable for reflecting sound, the echo sounder may very often show returns for double or even triple the depth in addition to the true sounding. It is usually possible to adjust the apparatus to eliminate the multiple returns, but this should not be done, since multiple echoes are valuable for the study of the composition of the ocean bottom.

(E) *Phantom Bottom*.—Many reports from reliable observers have been received in the Hydrographic Office indicating the existence of extensive banks in ocean areas definitely known to be of great depth. The depth over these banks, determined by echo soundings, always varied between 125 and 375 fathoms. A significant fact in connection with

these "phantom" banks was that they were always discovered in the daytime and never after dark. During the last few years the existence of a deep daytime sound-reflecting layer has been definitely established. Our knowledge of the character of this layer is still completely theoretical, one theory being that the layer is composed of a heavy concentration of squid which stays at the reported depths during daylight and moves up to the surface after dark to feed in the plankton-rich surface water. Phantom bottom may be confused with the true bottom unless the navigator is careful to check all suspicious soundings against known and charted depths.

(F) *Miscellaneous Errors*.—Many erroneous shoal soundings have been reported which could not be logically explained because the attending circumstances were not reported. In these cases the Hydrographic Office has no choice but to enter these soundings on the charts affected and take the first opportunity to verify or disprove the soundings by sending a survey ship to the area at a considerable loss of time and expense. However, if all pertinent details are supplied, it is often possible to disprove shoal soundings without putting them on the charts. A glaring instance of such a situation occurred in the Aleutian Islands when a ship, passing through one of the straits, recorded a continuous line of 7-fathom soundings where a recent survey indicated depths of 20 to 30 fathoms. Investigation disclosed that the ship had the anchor and 7 fathoms of chain out, so that, apparently, the flukes of the anchor had provided an almost perfect sounding board for the transmitted signal. Other erroneous soundings have been reported because of failure to allow the sonic depth recorder sufficient time to warm up after starting. At least 15 minutes should be allowed for the warm-up. Still other fictitious soundings have been reported because of accidental observing errors such as the reading of the wrong scale and the reading of the wrong edge of the signal. Mariners are urged to evaluate critically all soundings not agreeing with known or charted depths and to report all steps taken to confirm the data.

G (*Interference*).—A common occurrence in the operation of naval vessels requires that a number of ships steam in close column; to come alongside each other for fuel, stores, or personnel transfers. In these cases, if both vessels operate their echo sounders, interference will take place and the depth record may be almost impossible to interpret. Diagonal streaks across the fathogram are an indication of interference.

Officers in tactical command of more than one vessel should be alert to this possibility and designate only one vessel at a time to observe and record soundings. However, when possible, multiple lines of soundings should be obtained by having vessels in company steam abreast on a line of bearing with 5-mile interval between ships. One ship, preferably the one with the officer in tactical command on board, should maintain a plot of all ships' tracks, thus insuring relative accuracy of position and minimizing the plotting work.

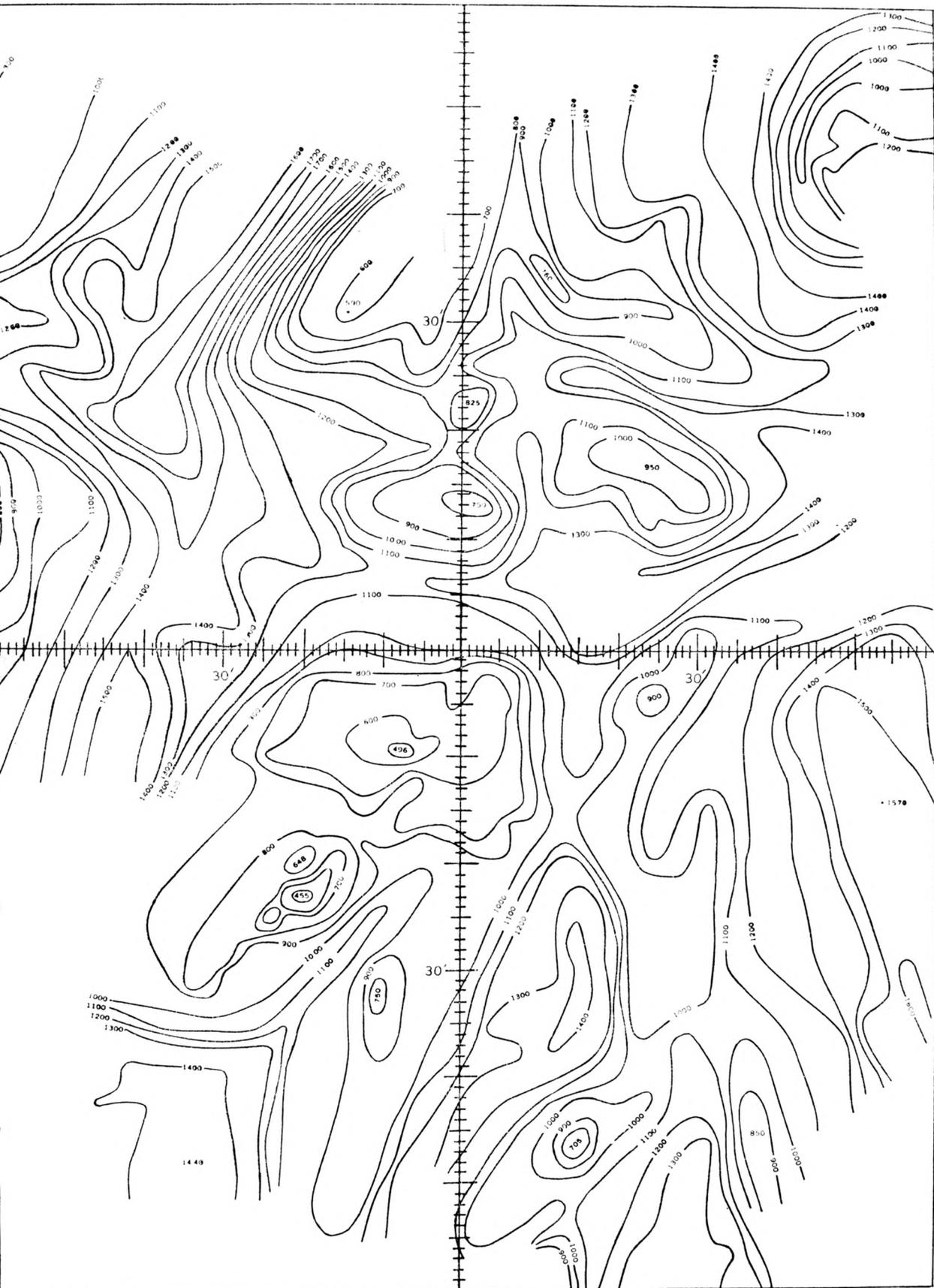
IV.—THE RECORDER

The automatic recorder, which is part of the standard equipment of most sonic sounding installations, is designed to provide automatically a graphic record of the depths below the ship's track up to a maximum of 2,000 fathoms. For proper operation of this recorder, the suggestions for operator's maintenance found in the instruction book furnished with the equipment must be closely followed. Experience has shown it to be essential to keep a close check on the stylus for cleaning and adjustment. The zero adjustment must also be closely watched.

The recorder should be operated whenever the depth and condition of the sea permit a record to be obtained. It has great value for chartmaking as it shows the extent of banks and submarine canyons and the minimum and maximum depths over them, which are not revealed by visual soundings taken at regular intervals. While it may seem that an excessive amount of recorder paper would be used, only a small part of the world's ocean area is less than 2,000 fathoms deep, and only 1 yard of paper is required for each 24 hours of steaming.

Although the recorders commonly installed on naval vessels have a design limit of 2,000 fathoms, a slight modification will enable this equipment to record up to 4,000 fathoms. Hydrographic and oceanographic survey vessels of the Navy, using the same equipment, record these depths as a routine matter. It will be noticed that the transmitted signal does not appear on the record. While it is desirable, from the standpoint of the Hydrographic Office, to obtain continuous recordings regardless of depth, it is not recommended that echo sounders installed on naval vessels be modified in this manner without express approval of the Bureau of Ships.

Figure 2 shows a section of the Atlantic Ocean bottom contoured from information provided by recordings. Notice the peak rising 5,400 feet above the canyon floor.



Section of Plotting Sheet showing bottom contours drawn from sounding tracks.

V.—THE SOUNDING REPORT

The chart showing the ship's track and soundings, which will become the main enclosure to the sounding report, should be kept as closely up-to-date as possible during the voyage. Every time the position of the ship can be reliably determined, the chart should be completed to that point. The report, to be sent directly to the Hydrographer, U.S. Navy Hydrographic Office, Washington 25, D. C., should consist of the following :

(A) A forwarding letter from the commanding officer or master stating where the soundings were taken, any difficulties encountered, type of equipment used, draft of the ship and an estimate of the reliability of the data reported. If the soundings have been corrected for draft, a notation to that effect should be made.

(B) The track chart showing the *corrected* ship's track, all navigational data, and soundings about 1/4 inch apart. The soundings should be marked for position by a dash on the track, opposite which, at an angle to the track, the actual depth in fathoms should be written.

(C) The depth curve on recorder graphs if any. The depth curve must be marked with the time at least every hour to correlate it clearly with the ship's track.

VI.—PROCESSING REPORTS OF SOUNDINGS

The receipt of sonic sounding reports in the Hydrographic Office will be acknowledged promptly. The information is first evaluated to see whether the issuance of a Notice to Mariners is required. After this, all essential information, such as the name of the ship, the date, the miles sounded, the ocean, and the master plotting sheets affected, is abstracted for placing on punch cards. The data is next transferred or plotted on the master sheets or charts, and the soundings are inspected for agreement with previous reports. If a line of soundings cannot be reconciled with the others, the line will have to be rejected, so that the time, both of the reporting vessel and of the Hydrographic Office, has been wasted. Since the personnel which can be utilized for plotting oceanic soundings is very limited, the Hydrographer is very desirous of having data submitted on the same scale as the master sheets used for compilation, so that the data can be transferred directly without the need for replotting.

