

INSERTION ON CHARTS OF ECHO SOUNDINGS AND THE CALIBRATION OF ECHO SOUNDING MACHINES.

Replies to Circular Letter N° 3-H of 7th January 1933.
(Report of the International Hydrographic Bureau).

The Third International Hydrographic Conference, April, 1932, had under consideration the question of the insertion of echo soundings on charts and also that of the calibration of echo sounding machines. The following resolutions were adopted by this Conference :

RESOLUTION N° 19 : *Echo Soundings on Charts.*

RESOLUTION N° 20 : *Standardisation of the Method for Calculating the Depth indicated by the Time Interval in Echo Sounding.*

- a) Echo distances of less than 1,000 metres will be transformed as well as possible into depths and then be inserted on charts in the same type of figures as that used for wire soundings.
- b) The scales of the echo sounding appliances should permit either rough echo distances or echo-intervals to be read. The signification of the scale shall be indicated on the apparatus itself (for a scale of length, the velocity on which it is based; for a scale of echo-intervals, the unit of time involved).

Further, the Conference invited the International Hydrographic Bureau to publish the different methods employed for inserting echo soundings on charts.

For the purpose of this study the I. H. B. published, on 7th January 1933, Circular Letter N° 3-H which requested the Hydrographic Offices kindly to supply certain information concerning the insertion of echo soundings on charts and the calibration of echo sounding machines, so that there might be available, for each country which draws up its own charts, a knowledge of the exact procedure used in computing the soundings plotted on such charts, thus making it possible for anyone using the chart thoroughly to understand the signification of the soundings inserted.

To date of writing, the following countries have sent detailed answers to the different queries contained in the Bureau's Circular Letter :

Norway; Sweden; Denmark; Germany; Netherlands; Great Britain (and Australia); Portugal; Italy; U. S. Coast and Geodetic Survey; U. S. Hydrographic Office; Argentina.

Japan informs the Bureau that its Hydrographic Department is continuing the study of this question and that, as soon as definite conclusions have been reached, it will not fail to communicate them to the I. H. B.

The following countries have replied to the effect that, for the present they have no special information to communicate in connection with these queries :

Siam; China; Monaco; Egypt; Brazil; Chile; Poland.

The following countries have not so far sent in their replies :

Russia; France; Belgium; Spain; Greece; Canada; Peru.

The following is a comparative list of the procedure adopted by the different countries according to the replies received to the various sections of Circular Letter N° 3-H of 1933 :—

QUESTION N° 1: What method does your Service use for inserting echo soundings on charts ?

NORWAY (6-II-1933). — *No decision has yet been made concerning the method for inserting echo soundings on our charts, as this question will not have actuality for some time yet.*

SWEDEN (21-III-1933). — *Not yet definitely decided.*

DENMARK (28-I-1933). — *The echo soundings are inserted on the charts in the same type as soundings by lead line.*

GERMANY (16-III-1933). — *The method used by the Nautische Abteilung der Marineleitung for inserting echo soundings on charts corresponds to that of Proposal I 19a and 20a submitted to the International Hydrographic Conference held at Monaco in April, 1932. (See also Report of Proceedings of this Conference, pp. 94 to 102). (Cf. also replies to Questions 5-10 below).*

NETHERLANDS (21-II-1933). — *All echo soundings, without any limit, are inserted on our charts corrected as well as possible.*

GREAT BRITAIN (Australia) (31-III-1933). — *Echo soundings are inserted in the usual manner.*

PORTUGAL (29-III-1933). — *Up to the present echo soundings have been used only as auxiliaries in the publication of charts. (See also replies to questions 6 to 11).*

ITALY (22-II-1933). — *Acoustic soundings are inserted on charts in the same way as that used for inserting other soundings.*

U.S.A. Coast and Geodetic Survey (7-II-1933). — *Echo soundings are reduced to depths by applying all corrections and depths are plotted in fathoms or feet depending upon scale of chart.*

U.S.A. Hydrographic Office (21-IV-1933). — *This Office has charted a limited number of echo soundings without correction and without distinction in character from other soundings. It is opposed to the methods set forth in paragraph 22 — 1 (a and b) on page 244 of the Proceedings of the International Hydrographic Conference, 1929, viz. —*

a) *That the soundings obtained by echo be plotted on charts after having been corrected as much as possible.*

b) *That they should not be distinguished from other soundings marked on the chart.*

The Hydrographic Office favours the adoption of a standard velocity for charting purposes, that is, a velocity to which soundings taken by instruments calibrated at various velocities should be reduced before charting. The soundings so reduced should be charted without further correction and in figures of a different character from soundings obtained by wire or other non-echo methods, provided, however, that echo soundings taken by Surveying and other

Vessels specially equipped for determining correction factors which must be applied to echo soundings to reduce them to true depths, will be charted after correction in the same manner and character of figures as soundings obtained by wire or any other non-echo methods.

ARGENTINA (8-IV-33). — *Echo soundings are inserted on the charts of our Hydrographic Service in the same manner as the other soundings.*

QUESTION N° 2 (a-b) : **Are the instruments used by your Service for taking echo soundings graduated in echo-intervals; and, if so, what method of regulating the apparatus makes it possible to verify the following facts :**

- a) **whether the indications given by the time mechanism are accurate within a fraction of a second;**
- b) **whether the zero of the time mechanism is in exact agreement with the emission of the signal ?**

NORWAY : *The instruments are not graduated in echo-intervals.*

SWEDEN : *The instruments are not graduated in echo-intervals.*

DENMARK : *The instruments used are :*

onboard the Fylla - Atlas Lot for depths to 1000 metres.

onboard the Hvidbjörnen - Atlas Lot, type 2.

onboard the Islands Falk - Ultrasonic sounding gear, type Langevin-Florisson.

GERMANY : *The instruments do not have scales graduated in echo-intervals.*

NETHERLANDS : *In the Netherlands East Indies a Hughes apparatus graduated in echo intervals (seconds and parts), is in use.*

- a) *Whether the indications given by the time mechanism are accurate, is verified by observing, by means of a stopwatch, the time interval for a great number of revolutions of the synchronised motor. According to the result the period of the motor is adjusted.*
- b) *The apparatus is so constructed that it is possible to verify whether the zero of the time mechanism is in exact agreement with the emission of the signal.*

GREAT BRITAIN (Australia) : *The instruments are not graduated in echo-intervals.*

PORTUGAL : *The instruments are graduated in depths. The echo-intervals may be deduced to 1/100 second by means of a meter.*

ITALY : *The acoustic appliances used by the Hydrographic Institute are not graduated in echo-intervals.*

U. S. Coast and Geodetic Survey : *The instruments are not graduated in echo-intervals.*

U. S. Hydrographic Office :

- a) *Indications given by the visual automatic depth indicators are accurate within plus or minus a fraction of a fathom, from 5 to 125 fathoms. Where the depth is determined by coinciding the outgoing and returning sound impulses, the indications of the elapsed time are accurate within plus or minus 0.01 to 0.02 second, depending upon the expertness of the observer. Where determination of depth depends upon the observer noting the position of a moving pointer when the echo is heard (such as fathometer white light method) the observations may be considered as correct within plus or minus 20 fathoms, depending upon the expertness of the observer in coinciding the eye and ear. This accuracy may be improved upon to some extent when the average of a short sequence of soundings is taken.*

- b) "Zero" of time mechanism is in exact agreement with the emission of the sound impulse for equipments employing Piezo-electric transmitters and impact (magnetic release) types of oscillators. A delay of 0.005 second due to magnetic reluctance and electrical impedance has been found in systems employing the Fessenden oscillator system.

ARGENTINA : Argentine Surveying Vessels use the British Admiralty apparatus.

QUESTION N° 3 (a-b-b1-b2) : Are the instruments used by your Service for taking echo soundings graduated in echo-distances? In the case of their being so graduated :

- a) Is the scale of the apparatus based on a fixed standard for the velocity of the sound, and if so what velocity of sound is used?
 b) Can the scale be altered at the time of use and adjusted for different velocities of sound in sea water?

What arrangement is made for calibrating the scale, i. e., to verify :

- i) the relation between the time recording mechanism and the scale in accordance with the velocities of sound used?
 ii) the coincidence of the zero of the scale with the departure of the signals?

NORWAY : The instruments are graduated in echo-distances.

- a) The scale of the apparatus is based on a fixed standard of 1500 m/sec. velocity of sound.
 b) The scale can not be adjusted for different velocities of sound.
 i) The two rotating discs in the depth indicator may be so adjusted as to secure full correspondence between the echo depths and the depths given by lead line over flat bottom.
 ii) The separation has been adjusted by the maker and is controlled by observing that the first red flash of the Neon tube coincides with the zero of the scale.

SWEDEN : The instruments are graduated in echo-distances.

- a) The scale is not based on a fixed standard for the velocity of sound.
 b) The scale may be adjusted for different velocities of sound.
 i) and ii) : The apparatus used is the ultrasonic Langevin-Florisson-Marti apparatus made by S.C.A.M., Paris. This apparatus is calibrated once every sixth week during use by comparison with wire-sounding at different depths.

These comparisons are made in the following manner :

The control soundings embrace a considerable number of different depths within the limits of depth which may be expected during the survey. Every test is made by about 100 wire soundings.

The tests are made during fair weather and, if possible, always on an even bottom of sand or clay; the casts with the lead are taken as near to the ultrasonic projector as possible.

By aid of a minor number of control soundings a preliminary curve is constructed giving the depth correction to the ultrasonic sounding for different depths. This curve is found to be a straight line, and on the basis of these values the speed of rotation of the time measuring apparatus is adjusted, and a new series of control soundings embracing about 100 casts at different depths is taken. As a rule this series will give a satisfactory agreement between supersonic and wire soundings and is generally used about six weeks, after which time a new test is made.

The proposed use of a fixed standard velocity of sound is not practical in the Baltic Sea, if satisfactory accuracy of sounding is aimed at, as large seasonal variations of velocity occur. Thus in the southern Baltic Sea the

velocity may be 1450 metres per second in autumn and in the northern Baltic 1121 metres per second in spring, i. e. a difference of 3-5 per cent from the value 1500 m.p.s. As it has seemed undesirable to introduce an uncertainty of this amount, no standard velocity has been used but the depths have been given corrected as much as possible, i.e. the echo depths have been made to agree with the wire depths. Thus the navigator, if he wishes to obtain the best possible results from echo sounding, should use the actual value of the velocity of sound for the local in question.

DENMARK :

- a) The Atlas sounding apparatus are based on the fixed standard velocity of sound of 1490 m/sec.
- b) The scale cannot be altered at the time of use nor adjusted for different velocities of sound in sea water.

GERMANY : The instruments are graduated in echo-distances.

- a) The scale is based on a velocity of 1500 metres per second.
- b) The scale cannot be altered during use. It is calibrated in the laboratory to a velocity of sound of 1500 metres per second. In use, the mechanism of the index can be controlled by means of a tachymeter or a stopwatch.

NETHERLANDS : An Atlas apparatus graduated in echo-distances (metres) is also in use in the Netherlands East Indies.

- a) The scale of the apparatus is based on a fixed velocity of sound of 1490 metres.
- b) The scale cannot be altered.
 - i) Whether the relation between the time recording mechanism and the scale is in accordance with the velocity of sound used, is verified by observing the time necessary for a great number of revolutions.
 - ii) The construction of the apparatus makes it possible to verify the coincidence of the zero of the scale with the departure of the signals.

GREAT BRITAIN (Australia) :

- a) Type 752 and Deep Water Gear in "Ormonde": 800 fathoms per second. Deep Water Gear in "Challenger" has also been used with the velocity corresponding to 1,500 metres/second.
- b) The scale can be adjusted for different velocities of sound, but the adjustment of the motor speed is not a convenient method with existing governors.
 - i) The correlation is verified by timing the speed of motor with a stop watch from the number of transmissions per second, and by checks with line soundings.

N.B. The motor governors in Type 752 can be relied on to keep the speed constant to within $\pm 1/2\%$ in spite of changes in mains voltage or load. In the deep water gear the governed speed is accurate to within $\pm 0.2\%$.

- ii) In all types the transmitter is operated by a switch geared to the time measuring apparatus, and allowance is made for the lag between operating the switch and sending out the sound.

In Type 752 the lag is measured at the Maker's Works, and is between 21 and 22 echo feet, and the maximum variation under working conditions does not exceed ± 1 foot.

The actual lag in echo feet is engraved on each transmitter.

In the deep water gear the corresponding lag is 17 fathoms and the maximum variation is ± 2 fathoms.

In Type 752 and "Ormonde's" gear this lag is assumed to be constant, but in "Challenger's" deep water set a "test hydrophone" operated by the transmitted sound records a true zero mark on the recorder.

In the motor boat gear the lag between operating the switch and emitting the sound is very small.

In all cases the zero on the depth scale is set back by an amount equal to the mean depth of the transmitter and receiver below the surface of the sea at normal draft.

In Type 752 the scale is proportioned to correct the error due to the separation between the transmitter and hydrophone. In the motor boat gear and deep water apparatus the separation error is negligible at greater depths than 4 feet and 50 fathoms respectively.

PORTUGAL : *The graduation in echo-distances is based on the standard velocity of 1500 m/sec.*

i and ii) *The scale of the apparatus is invariable but coincidence may be established between the departure of the signal and the zero of the scale.*

ITALY : *The instruments are graduated in echo-distances.*

a) *The scale of the apparatus is based on the standard fixed velocity of 1500 m/sec.*

b) *The scale cannot easily be changed.*

U.S.A. (Coast and Geodetic Survey) : *The instruments are graduated in echo-distances.*

a) *Scale, fixed standard. Two ships using 800 fathoms per second, 7 ships using 810 fathoms per second, and 5 ships using 820 fathoms per second. Each ship making necessary corrections for temperature, salinity and pressure to reduce sounding to depth.*

b) *The scale of the apparatus cannot be adjusted at time of use for different velocities of sound.*

i) *The speed of rotation is kept constant by a governor and this speed verified at all times by a vibratory tachometer.*

ii) *The fixity of the zero is checked, first, by running indicator slowly and noting where the actuating circuit operates; second, by frequent checks in depths of 12 to 20 fathoms with ship stationary over flat bottom, and after applying corrections for temperature and salinity set departure of signal so that correct reading is obtained.*

U.S.A. (Hydrographic Office) : *The instruments are graduated in echo-distances.*

a) *The fathometer class of echo sounding equipment as manufactured for the Navy by the Submarine Signalling Company is designed for a velocity of 4920 ft. All other types used by the Navy are designed for a velocity of 4800 feet.*

b) *Scales of the direct reading type cannot be altered to compensate for various velocities, nor does such an arrangement appear desirable. It is believed that more reliable data are obtained when a fixed calibration is employed and the proper corrections applied thereto.*

ARGENTINA : *The instruments are graduated directly in feet and are adjustable.*

QUESTION N° 4 : Do the echo sounders used by your Service bear on the instruments an indication of what the scale represents, i. e. for a linear scale, the velocity on which it is based or for a scale of echo-intervals, the unit of time employed ?

NORWAY : *Yes : 1500 m/sec. is indicated on the front of the depth indicator.*

SWEDEN : *No : This indication is stated in the description of the apparatus received from the maker.*

DENMARK :

GERMANY : *The machines bear a plate indicating the 1500 metres per second velocity of sound used.*

NETHERLANDS : *No.*

GREAT BRITAIN (Australia) : *In Type 752 the scales are marked in fathoms and the speed is adjusted to send three transmissions per second for a velocity of 800 fathoms/sec. The speed and corresponding velocity are given in the Handbook supplied with the gear.*

PORTUGAL : *The value of 1500 m./sec. is indicated in the Instructions which accompany the instrument.*

ITALY : *The appliances are not marked with this velocity, but it is on the basis of this velocity that it was decided to graduate them.*

U. S. A. (Coast and Geodetic Survey) : *No.*

U. S. A. (Hydrographic Office) : *Direct reading dials carry an indication of the velocity upon which they are based. The "Time Elapse" dials are direct readings in "signals per second" and a table of depths is furnished for ready conversion to fathoms based upon a velocity of 4800 feet.*

ARGENTINA : *No.*

QUESTION N° 5 : Does your Service use tables for correcting the velocity of sound « in situ », to enable the local temperatures and densities (whether measured or estimated) to be allowed for; and, if so, what tables ?

NORWAY : *No.*

SWEDEN : *No : this is done empirically as stated in answers to N° 3 above.*

DENMARK : *No tables for correcting the velocity of sound are used, mainly because the standard velocity of the sound 1490 m. for the waters round Iceland and Greenland with depths up to 3000 m. is very nearly the same as the velocity according to Tables of the velocity of sound in pure water and sea water, N° H.D. 282, published by the Hydrographic Department, London.*

GERMANY : *In cases where echo soundings have to be corrected (Cf. Questions 6 to 10) we use the Tables of the British Hydrographic Department (H.D. 282) for this purpose and the supplements to these tables published in the Beiheften N° 10/1930 and N° 12/1931 to the Nachrichten für Seefahrer, besides the tables contained in Volume II of the book entitled : Deutsche Atlantische Expedition auf dem Forschungs— und Vermessungsschiff "Meteor".*

NETHERLANDS : *The British Tables of velocity of sound etc., H.D. 282, are used.*

GREAT BRITAIN (Australia) : *British Admiralty Tables of the Velocity of Sound in Pure Water and Sea Water for use in Echo Soundings and Sound Ranging, H.D. 282. Table I; and also improved local tables in some cases.*

PORTUGAL : *The Tables of the British Admiralty are used.*

ITALY : *When necessary and possible the soundings are corrected with the British Admiralty tables. In exceptional cases in which the local temperature and density have been observed and where correction is necessary, this correction is calculated from the same tables.*

U. S. A. (Coast and Geodetic Survey) : *Yes : British Admiralty.*

U. S. A. (Hydrographic Office) : *Our Service does not as yet use tables for correcting the velocity of sound. We are in favour of the use of such tables when sounding data include information necessary for their use.*

ARGENTINA : *No tables used.*

QUESTION N° 6: Before inserting echo soundings on the chart does your Service apply corrections to them, such as for the slope of the bottom; in the case of slope corrections does your Service displace the sounding from the position where it was taken to the vertical from the point of reflection or does it merely apply a plus correction to the sounding without displacing it or does it apply a combined correction for both depth and position?

Does your Service apply a correction based on a control sounding by lead line; or a correction for the vertical movement of the tide?

NORWAY: Owing to the rapidly changing bathymetric configuration in the Norwegian archipelago one never knows with certainty whether a received echo is reflected from a horizontal or from a sloping bottom, not to speak of the uncertainty as to the eventual degree of inclination. Thus the value of a correction for slope will be delusive, and accordingly no such correction has been applied. Corrections for variations in the velocity of sound are applied based on control soundings by lead line over flat bottom.

SWEDEN: The soundings are corrected as far as possible before being inserted on the charts, also for water-level changes. No correction is however applied for slope of bottom on account of the ultrasonic type of the apparatus and the small depths which seldom exceed 200 metres in the Swedish coastal waters.

DENMARK: No corrections are applied to the soundings before inserting them on the charts.

GERMANY: The slope of the bottom is not allowed for. The position of the echo is assumed to be that of the ship. The vertical movement of the tide has hitherto not been taken into consideration either.

NETHERLANDS: No corrections, such as for the slope of the bottom, are applied on echo soundings before inserting them on the chart; neither are the positions, where they are taken, displaced. No corrections are applied based on control soundings by lead line nor for the vertical movement of the tide.

GREAT BRITAIN (Australia): No slope correction is applied. Shallow soundings are corrected by frequent control soundings with the lead line. Deep soundings are not so corrected. A correction for the vertical movement of the tide is applied.

PORTUGAL: The value of the sounding within a cone of 8°, concurring with the wire sounding, is used. A correction for the height of the tide is applied.

ITALY: No corrections are applied for the slope of the bottom. No corrections for tides are applied beyond depths of 20 metres. Tidal corrections are applied in depths of less than 20 metres.

U. S. A. (Coast and Geodetic Survey): Correction is always applied for slope unless the displacement is less than the size of the indicating figures for depth on the chart.

U. S. A. (Hydrographic Office): This Service does not consider that a correction for slope is necessary in cases where supersonic echo sounding equipment is employed. There is considerable doubt as to the practical determination of slopes, except where a continuous line of soundings is made on a course bisecting a ridge or depression. There are no features in ordinary low frequency sounding systems by means of which the location of points of reflection can be determined.

ARGENTINA: Our echo sounding instruments are adjustable and are checked permanently by mechanical wire sounding. The state of the tide is taken into account in applying corrections to the soundings.

QUESTION N° 7: Are the corrected echo soundings inserted on the charts by your Service in different characters from those used for soundings by lead line?

- NORWAY : *No decision made* (See answer N° 1).
 SWEDEN : *No.*
 DENMARK : *No corrections are applied to the soundings before inserting them on the charts.*
 GERMANY : *Echo-distances up to a depth of 200 metres (and in exceptional cases somewhat more) are corrected for the local velocity of sound; the greater echo-distances are not corrected. The corrected echo soundings are inserted on the charts as wire soundings, i. e. in sloping characters.*
 NETHERLANDS : *No.*
 GREAT BRITAIN (Australia) : *No.*
 PORTUGAL : *No. Same type of figures used.*
 ITALY : *A single type of figures is used for the insertion on charts of all soundings.*
 U. S. A. (Coast and Geodetic Survey) : *No.*
 U. S. A. (Hydrographic Office) : *At present, no.* (See answer to Question 1).
 ARGENTINA : *No: all soundings are inserted on the charts in the same type of figures.*

QUESTION N° 8: Are uncorrected or partially corrected echo soundings inserted on your charts in different characters from those used for soundings by lead line?

- NORWAY : *No decision made.* (See answer N° 1).
 SWEDEN : *No.*
 DENMARK : *No.*
 GERMANY : *Echo-distances above 200 metres are not corrected and are inserted on the charts in upright characters.*
 NETHERLANDS : *No.*
 GREAT BRITAIN (Australia) : *No.*
 PORTUGAL : *No. The same type of figures is used as for the soundings by wire.*
 ITALY : *A single type of figures is used for the insertion on charts of all soundings.*
 U. S. A. (Coast and Geodetic Survey) : *No.*
 U. S. A. (Hydrographic Office) : *At present, no.* (See answer to Question 1).
 ARGENTINA : *The Hydrographic Service inserts on its charts only such soundings as are considered to give absolute security. For this purpose only one type of figures is used.*

QUESTION N° 9: Does your Service keep special characters (heavy or hair-line) for the insertion of soundings other than uncorrected echo soundings, i. e. certain soundings of a special nature or origin?

- NORWAY : *The depths of sunken rocks are indicated by heavy vertical block figures, while all other depths are inserted in inclined light italics.*
 SWEDEN : *No.*
 DENMARK : *Depths over wrecks and rocks or stones are inserted in block-types.*
 GERMANY : *Apart from the indications given above for Questions 7 and 8, no special characters are used.*
 NETHERLANDS : *No.*

GREAT BRITAIN (Australia) : *No.*

PORTUGAL : *No.*

ITALY : *A single type of figures is used for the insertion on charts of all soundings.*

U. S. A. (Coast and Geodetic Survey) : *No.*

U. S. A. (Hydrographic Office) : *No, except that on a few charts soundings in leaning figures are used to indicate portions of the chart enlarged from smaller scales or taken from very old surveys.*

ARGENTINA : *The Hydrographic Service inserts on its charts only such soundings as are considered to be absolutely sure and for this purpose a single type of figures is used.*

QUESTION N° 10 : Does your Service, when charting echo soundings taken beyond certain depths, round off the last digits to the nearest ten ? If so, what rules does it follow on this subject ?

NORWAY : *No.*

SWEDEN : *No; the depths are given to the nearest metre.*

DENMARK : *The soundings are not rounded off.*

GERMANY : *Echo-distances between 40 and 200 metres are inserted on the charts after being rounded off to the nearest whole number. Those above 200 metres are rounded off to the nearest 5 metres.*

NETHERLANDS : *The echo soundings observed during the Snellius expedition were rounded off to the nearest ten if the last digit was four or less; otherwise they were rounded off upwards.*

GREAT BRITAIN (Australia) : *No.*

PORTUGAL : *The scale is graduated in divisions of 2 metres. Estimation is made to the half metre up to 50 metres and to the metre for depths between 50 and 300 metres.*

ITALY : *Acoustic soundings are inserted rounded off in the same way as others, viz., to the nearest decimetre in depths of or less than 20 metres, to the nearest metre in depths of more than 20 metres.*

U. S. A. (Coast and Geodetic Survey) : *No. Depth charted to nearest fathom.*

U. S. A. (Hydrographic Office) : *No.*

ARGENTINA : *Echo soundings are inserted in whole fathoms, rounding off to the nearest lower figure.*

QUESTION N° 11 : Does your Service make a distinction on its charts between soundings obtained by audible and supersonic methods ?

NORWAY : *The audible method is the only one in use.*

SWEDEN : *No. All echo soundings made by this Service have hitherto been executed by the ultrasonic method.*

DENMARK : *No.*

GERMANY : *No distinction.*

NETHERLANDS : *No.*

GREAT BRITAIN (Australia) : *No.*

PORTUGAL : *No.*

ITALY : *No distinction is made on charts between sonic and ultrasonic soundings.*

U. S. A. (Coast and Geodetic Survey) : *No.*

U. S. A. (Hydrographic Office) : *No.*

ARGENTINA : *None of our Surveying Vessels are fitted with ultrasonic sounding machines.*

QUESTION N° 12: Has your Service had occasion to make simultaneous comparison between soundings by lead line and echo soundings?

NORWAY: *At fixed intervals simultaneous comparisons are taken between echo soundings and soundings by lead line.*

SWEDEN: *Yes. See under (6).*

DENMARK: *Have no experience with regard to this question.*

GERMANY: *Soundings by lead line and echo soundings are compared as often as possible. Volume II of the Deutsche Atlantische Expedition auf dem "Meteor" contains copious results of observations on this subject.*

NETHERLANDS: *The Commanding Officer of Hr. M. surveying vessel Willebrord Snellius made an extensive study of these subjects. Results will be published.*

GREAT BRITAIN (Australia): *Yes, this is done frequently and under varying circumstances as a check.*

PORTUGAL: *This concordance is always made.*

ITALY: *To check the appliance, frequent check soundings are taken with wire.*

U. S. A. (Coast and Geodetic Survey): *Yes.*

U. S. A. (Hydrographic Office): *Yes.*

ARGENTINA: *Yes; these comparisons are always made.*

QUESTION N° 13: What apparatus (or apparatuses) does your Service use, and what degree of accuracy does your Service attribute to echo soundings taken at different depths with them, making allowance for various sources of error, i.e. zero error of the scale, inaccuracy of the scale, error in reading the scale, error in regulating the speed of the time apparatus, error due to the velocity of sound on the spot, error in the position of the sounding?

NORWAY: *Apparatus used: Atlas-Lot Type XVI from Atlas Werke, Bremen, with visual reading (red light method) from 0-500 metres, and visual-acoustic method (white light method) from 0-1500 metres.*

Apart from errors caused by slope, it is our opinion that practically full accuracy is obtained in the readings between 0-500 m.

During last year's experimental echo sounding on the outer coast off Bergen, the frequent comparisons between lead line soundings and echo soundings showed that a velocity of sound of 1500 m/sec. agreed very well with the local conditions.

It was found that a simple but at the same time quite sufficiently accurate method of determining the velocity of sound was to make comparisons in known depths.

SWEDEN: *With the apparatus used by this Service (See under 3) it has been found by the periodic controls according to (3) that the total error of a supersonic sounding does not reach 2 per cent of the depth sounded.*

DENMARK: *Have no experience with regard to this question.*

GERMANY: *The apparatus used hitherto are the following: Echolot of the Atlas-Werke, Bremen; Echolot of the Behm-Echolotgesellschaft; Kiel; Echometer of the Echometergesellschaft, Kiel.*

The zero error of the scale is less than 0.1 divisions of the scale. The error in reading the scale is of the order of 0.5%; the error in regulating the speed of the time apparatus < 0.5%. For the error due to the velocity of sound on the spot, cf. Question N° 5.

The error in the position of the sounding is the error in the position of the ship. (Cf. Question N° 6). The possible error in the ship's position in the

open sea is usually contained within a circle of 1 Nautical Mile radius, but in the vicinity of the coast the circle is of appreciably smaller radius.

NETHERLANDS : For apparatus used see above. Answers to the other questions will be found, after publication, in the study mentioned sub 12.

GREAT BRITAIN (Australia) : Motor-Boat Set 0-200 feet. This system consists of a separate high frequency transmitter and high frequency receiver fitted in trunks in the motor boat; the distance between the trunk centres being 1 1/2 feet. Echoes are recorded on a chemical recorder and the depth can be read to within ± 1 foot. The timing should be accurate to less than $\pm 1\%$. The instrument is calibrated by frequent comparison with wire soundings and it is considered that the depths are accurate to $\pm 1\%$.

Type 752. A sonic system employing an electrically operated spring driven transmitter fitted inboard with an inboard hydrophone separated some 50 feet from the transmitter. Echoes can be located to the nearest foot on the scale. As in the motor boat set above, the instrument is calibrated by frequent comparison with wire soundings and it is considered that the depths are accurate to $\pm 1\%$.

Deep Water Gear in "Challenger" and "Ormonde". The transmitter is of the hammer type operated pneumatically and controlled electrically and emits a damped note of 2,000 cycles per second. Both the transmitter and hydrophone are fitted inboard with a separation of about 75 feet. Echoes are recorded on chemical recorder and a phasing system is employed which, in effect, gives a record width of 21 inches for 1000 fathoms. The position of the echo on the trace can be read to within ± 1 fathom, by interpolation at all depths. During "Challenger's" recent passage to Newfoundland soundings obtained on level bottoms by line and echo showed the following differences (see attached sheet), after applying corrected velocities obtained from H.D. 282.

More accurate corrections for velocity should be obtained from the actual temperature and salinities measured at the bottling stations.

Estimates of slope correction are given in "Osprey's" Report "Deep Water Echo Soundings in Challenger and Ormonde" dated December 1932. *

Position	Recorded Depth Fm. Based on Velocity of 820 Fm/Sec.	Sounding Region (H.D. 282)	Velocity given by Table 1 or 2 & 4 (H.D. 282)	% Correction for Gradient	Corrected Depth Fm.	Lucas Line check Sounding	Difference fathoms	% Difference	Velocity corresponding to Lucas Soundings Fm./Sec.
"Challenger"									
Stn. 1	449	7	815	—	446	446	0	0%	815
» 2	2491	7	822	—	2498	2496	2	+ 0.08%	821.7
» 8	2396	17	(extrapolated) 821	—	2400	2392	8	+ 0.33%	819
» 11	152	17	(extrapolated) (802 + 2.5) (= 804.5)	—	149	149	0	0%	804.5
» 12	73	17	(806 + 1.5) (= 807.5)	—	72	72	0	0%	808
"Ormonde"									
Stn. 1	1110	5	820	+ 2.0%	1132	1135	3	— 0.26%	(822)
» 2	2135	5	824	+ 0.8%	2160	2165	5	— 0.23%	(828)

* Hydrographic Review Vol. X, N° 2, November 1933, p. 154.

PORTUGAL : *On even bottom, less than 5% from line sounding is obtained; on uneven bottom (West and North of Berlenga Island), about 25%.*

ITALY : *The Hydrographic Institute uses various well-known types of sonic and ultrasonic appliances now on the market. The Surveying Vessel Amm. Magnaghi is provided with a fathometer of the Submarine Signalling Corporation and an ultrasonic echometer of the Langevin-Florisson type. Both these appliances have worked normally.*

U. S. A. (Coast and Geodetic Survey) : *10 to 100 fathoms, 1 to 2% depending upon the nature of the bottom.
100 to 1000 fathoms, 1%.
1000 fathoms to deepest, better than 1%.*

U. S. A. (Hydrographic Office) : *This Service uses the Submarine Signalling Company's fathometer and the supersonic echo sounding equipment of Navy design. Another type of sounding equipment, which is gradually being dropped, is the "time elapse interval sonic depth finder" as developed by the Engineering Experimental Station at Annapolis. There is at present insufficient data on hand to definitely determine the degree of accuracy of echo soundings and the rapid progress being made in the improvement of the equipment and methods to eliminate instrumental and personal errors precludes any definite answer. Sufficient progress has been made in the determination of the salinity and temperature of sea waters in different localities to justify the belief that in a short time some dependable factor will be evolved for correcting sonic soundings.*

ARGENTINA : *We use the Admiralty apparatus. Its errors are more or less the same as those of mechanical sounders.*

QUESTION N° 14 : Has your Service adopted a limit depth within which echo soundings are not corrected ?

NORWAY : *Not for the present.*

SWEDEN : *No : See question (6) above.*

DENMARK : *No.*

GERMANY : *All echo distances under 200 metres are corrected for the local velocity of sound.*

NETHERLANDS : *No.*

GREAT BRITAIN (Australia) : *No.*

PORTUGAL : *Not as yet : soundings beyond 300 metres are not used.*

ITALY : *Soundings of more than 20 metres are not corrected except in the cases mentioned in (5).*

U. S. A. (Coast and Geodetic Survey) : *No.*

U. S. A. (Hydrographic Office) : *This Service has not as yet adopted a limited depth within which echo soundings are uncorrected. This matter has been given careful study.*

ARGENTINA : *Yes : of and above 20 fathoms.*

QUESTION N° 15 : Does your Service indicate, by a special note on your charts or in the Sailing Directions, whether the echo soundings are corrected, or the standard velocity used for calculating the echo distances ? Further, does it indicate in this note the limit within which the soundings are not corrected ?

NORWAY : *Not for the present.*

SWEDEN : *No; on all charts the depths are given corrected as far as possible, without indication regarding the manner by which they were obtained. See also under (6).*

DENMARK : *No.*

GERMANY : *German Admiralty Chart N° 1 contains information concerning the velocity of sound used for echo soundings and the indication by upright characters of echo-distances above 200 metres.*

NETHERLANDS : *No.*

GREAT BRITAIN (Australia) : *No.*

PORTUGAL : *Not as yet.*

ITALY : *Answer negative.*

U. S. A. (Coast and Geodetic Survey) : *No.*

U. S. A. (Hydrographic Office) : *No.*

ARGENTINA : *No.*

QUESTION N° 16 : Has your Service made, or does it intend to make experiments to measure the rate of vertical propagation of sound in sea water?

NORWAY : *Not for the present.*

SWEDEN : *No; not at present.*

DENMARK : *No.*

GERMANY : *No experiments.*

NETHERLANDS : *No.*

GREAT BRITAIN (Australia) : *No tests other than those noted above are in hand in "Osprey".*

PORTUGAL : *Not as yet.*

ITALY : *Answer negative.*

U. S. A. (Coast and Geodetic Survey) : *Extensive experiments have been made.*

U. S. A. (Hydrographic Office) : *No tests for vertical propagation for sounding sea water have been made, nor is there any intention at present of making these tests. Tests, however, have been made for horizontal propagation.*

ARGENTINA : *No.*

QUESTION N° 17 : What is the shoalest depth in which the echo method is used in your Service ?

NORWAY : *During the experiments with the Atlas-Lot accurate depths were read down to 5 metres (3.5 m. below the keel). Instructions for the use of echo sounding in shallow waters will be given when the necessary experience has been gained through further practical experiments.*

SWEDEN : *6 metres.*

DENMARK : *As mentioned hereafter in "General Remarks" at present our Service does not use echo sounding in the surveying ships.*

GERMANY : *Echo soundings are used on charts from 40 metres upwards.*

NETHERLANDS : *Not yet fixed.*

GREAT BRITAIN (Australia) : Motor Boat Gear : *Clear records can be obtained in depths not less than 4 feet with the experimental model, but with the present recorder (where 4" on the record = 200 feet), the error in reading the depth amounts to $\pm 1/2$ to ± 1 foot.*

Type 752. *With less than 2 fathoms below the hull the error in measurement is about ± 3 feet. For survey purposes Type 752 is not employed in depths less than 10 fathoms.*

PORTUGAL : *10 metres. In fact, for lesser depths the transmission signals interfere with those of the echo.*

ITALY : *The minimum depth in which the acoustic method is used is in from 10 to 12 metres.*

U. S. A. (Coast and Geodetic Survey) : *8 fathoms.*

U. S. A. (Hydrographic Office) : *The shoalest depth at which the best high frequency echo sounding systems can be depended upon is 2 feet below the keel; for the fathometer about 5 fathoms below the keel; for the "time elapse" method about 50 fathoms.*

ARGENTINA : *90 feet.*

GENERAL REMARKS.

NORWAY : In Norway the use of echo sounding will probably to a great extent depend on the local bathymetric configuration.

During deep sea sounding off the coast, on some open stretches of the coast and on fishing banks the ocean bed will generally be so smooth and regular that echo sounding may be used without incurring errors of any importance.

But in our archipelago the bathymetric configuration will generally be so irregular and change so rapidly that great slope errors may be incurred at any time, whereas a correction for slope, as mentioned under (6), will be delusive.

The latter case therefore presents two alternatives :

The echo distances must either be considered as being also true depths or considered as being only *rough* echo distances.

The first alternative may occur when the hydrographer in charge after careful study of the results can take it for granted that there is no appreciable bottom slope, and the echo distances are then entered as ordinary soundings by lead line.

The second alternative occurs when the hydrographer finds that there is an appreciable slope, in which case the echo distances are entered as *rough* echo distances only. Such a distance must, if inserted in a chart, be distinguished from ordinary soundings.

As the characters for ordinary soundings greatly vary, the best method for inserting *rough* echo distances will probably be to place them within brackets. Or the distances may be written in characters differing from those used for the chart's ordinary soundings.

In a condensed form our opinion is :

- 1) Provided that corrections for velocity of sound and tide have been applied, there should be no fixed depth limit for using echo distances as true depths in contrast to rough echo distances.
- 2) But the limit should be based on the bathymetric configuration.
- 3) Echo distances, which are also considered as true depths should be inserted in charts in the same manner as soundings by lead line.
- 4) Rough echo distances should be distinguished in a prominent way, and an explanatory note entered on the chart.

The hydrographer in charge decides, after careful study of the hydrographic work, which distances shall be entered as true depths, which shall be considered as rough echo distances only, and again which of these latter are of importance to the chart.

Local areas which are thus left standing as rough echo distances, shall then be verified to the necessary extent by lead line.

In consequence of the opinion stated above, echo sounding will probably be of considerably limited use as far as hydrography goes in the Norwegian archipelago.

DENMARK : As the surveying vessels in Danish waters since 1926 merely have been engaged in sweeping operations and minor surveys along the coasts, we have not yet deemed it necessary to install Echo-sounding apparatuses in them. Echo-sounding apparatuses however have been installed in the Danish Fishery-Cruisers and are used by them for obtaining soundings in Arctic waters, as well as for navigational purposes in general.

