

The specific volume is the reciprocal of the density. It is denoted by the Greek letter α .

The specific gravity of the average oceanic water at 0°C under atmospheric pressure is 1.02800, or $\sigma_0 = 28.00$. This water, the salinity of which is 34.85 ‰, is commonly used as a standard of reference.

Its specific volume is known for various pressures, and the specific volume of another water at another temperature at these pressures can be obtained by adding certain corrections called "differences" or "anomalies". These corrections are tabulated here for standard pressures and referred to σ_t and the temperature. The formula is as follows :

$$\alpha\sigma_t, t = \alpha 28.00 + \sigma_t + \delta\sigma_t + \delta\sigma_t, t$$

The tables are intended for the calculation of the specific volume of ocean waters to 5 places of decimals, but they have been carried to 6 places in order to increase the accuracy. The intervals in t and σ_t are so small that interpolation is easy or unnecessary. The corrections for the less saline waters, for which σ_t is less than 18.00, are given only to 5 places.

The first part of the tables gives the correction for temperature, σ_t , to 6 places. The second part gives the corrections for σ_t , $\delta\sigma_t$, to 6 places, and also a third small correction for σ_t, t . This correction is negligible in many cases.

At the end there is a table of the specific volume of the reference water, $\sigma_0 = 28.00$ and $t = 0^\circ\text{C}$., for standard pressures, and another for use in interpolation.

The tables were calculated with the help of KNUDSEN'S *Hydrographical Tables* 1901 and W. EKMAN'S *Tables for Sea-Water under Pressure*, Copenhagen, 1910.

HYDROGRAPHIC AND GEODETIC SURVEYING MANUAL FOR THE USE OF U. S. NAVAL SURVEYS

(H.O. Publication N^o 215 of the U.S. Hydrographic Office, Washington, D.C., 1937)

by

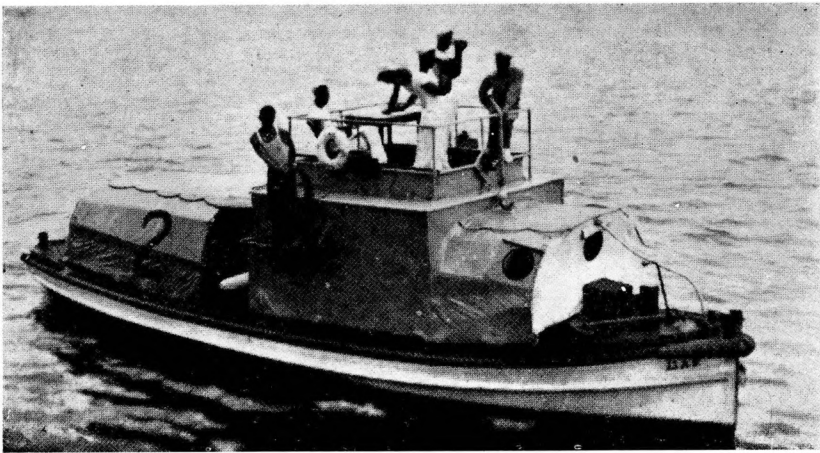
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(252 pp., 106 figures, 23 Tables and Appendices : Price \$ 3.00).

The object of this new publication brought out by the U.S. Hydrographic Office is to present in convenient form all the necessary elements required for the execution of hydrographic and geodetic surveys together with a description of the equipment and methods employed. The subject matter is based primarily on the experience acquired and on the reports furnished by the personnel participating in the surveying expeditions of the U.S. Navy during the past forty years.

The first three chapters are devoted to descriptions of the equipment, reconnaissance and erection of the survey signals.

With regard to equipment, descriptions and very complete lists are provided of the instruments, tools, machinery and materials required for the ordinary surveys. The most important among those described are :— invar tapes Bureau of Standards model with the portable tripod, the stainless steel tapes and piano wire tapes for precise traverse ; the sextants and quintants used in connection with sounding operations, the latter being fitted with a vernier having a quick-clamping device ; the eight-inch, ten-second transit theodolite which is particularly useful for observing the angles from tower-heads ; the altazimuth instrument which is more convenient for the observation of stars from the ground and the surveyors' transits fitted with stadia wires. For naval survey operations a small light theodolite has been chosen, weighing eleven pounds with tripod, having a 5 1/2 inch horizontal circle and an eyepiece magnifying about 18 diameters. The signal lamps for long sights in geodetic surveys equipped with a telescope for perfecting the alignment ; the various types of stadia rods, levels and poles and the stadia boards, are also mentioned. Three different types of protractors are indicated : one with 3 arms, 18-inch size with an extension of 13 1/2 inches, diameter of limb 6 inches, vernier reading to one minute ; another type with three arms of xylonite, arm of 13 1/2 inches, reading to two minutes ; and



Embarcation armée en sonde
Launch engaged in sounding.

a so-called "triangulation protractor" having only one plotting arm consisting of a single piece of metal 36 inches long with a vernier reading to ten seconds (*Nokomis* 1928 type).

The automatic tide gauge of the U.S. Coast and Geodetic Survey is described in detail as well as the various automatic devices for the measurement of current such as the EKMAN, CARRUTHERS, PETTERSSON and IDRAC types.

The use of ordinary photographic apparatus is recommended as well for the illustrations in the Sailing Directions as for supplementing the triangulation stations. The use of the camera with telephoto attachment and ray filters is also recommended, including the WRATTEN filters K2, K3 and G for eliminating effects of haze. Finally a small range finder is recommended for completing the traverses for locating points out of range of the stadia board and inaccessible points on swampy shores, as well as controlling points of cliff lines paralleling a shore.

The material and apparatus, as well as the instruments and machines required for hydrographic work, are the object of detailed lists included in Appendix I of the volume. This appendix also contains a very detailed list for a reference library which might be carried aboard the surveying ship, and also lists of all the material and instruments needed for field measurements, for signal construction, for sounding work, for office plotting, for the various record books and forms, and for the camping accessories.

Finally Chapter I contains information regarding medical precautions to be taken in the case of snake-bites, insect bites or poisoning from plants which might be encountered in the course of the surveying operations ashore.

In the chapter devoted to reconnaissance, although the methods followed may be rather varied, there is given a method of reconnaissance by the surveying ship with a view to acquiring in an expeditious manner the maximum amount of essential information by a judicious division of labour amongst the observing personnel. It is recommended that two sheets be prepared; one on which the details of interest to the navigator of the ship are plotted and the other containing the data of primary interest to the surveyor. The result of the reconnaissance is obtained by combining the two sheets, after the adjustments have been made, on a third sheet intended to be basic for future planning and layout sheets.

The same chapter contains a description of the method of estimating distances by means of the depression of objects below the horizon; the data for determining the intervisibility of towers, and practical considerations governing the spacing of towers; on the lay of the triangulation and the expansion of the base.

In the third chapter is given a description of the method of erecting signals for the three types usually employed by the U.S. Navy, viz:— the improved steel triangulation tower, one hundred feet high (seven sections), weighing 3 1/2 tons; a forty-foot tripod tower, type U.S.S. *Niagara*, 1926; a four-legged wooden water tower which can be erected at sea and can be assembled aboardship and swung overside with the winch; and a four-drum three-anchor floating signal of the U.S.S. *Hannibal* type, 1915.

In recent surveys there has been a tendency towards uniformity in all these types of survey signals: this for the purpose of saving time, since the ship can then go to the field with a supply of each type of signal previously constructed and knocked-down, leaving only the erection to be done, so that upon arrival at the field only a few days are required to signal out the area to be surveyed.

Chapter IV of the Manual is devoted to sounding. First the boat soundings are discussed with the special equipment illustrated in the accompanying figure. The Manual treats in the first place of the division of work amongst the sounding units, the daily record, and field record numbers for boat sheets. Some space is devoted to the question of training the personnel of the sounding parties, the duties of each being explained in detail. This chapter also contains the method of obtaining fixes from the boat by three points; the choice of scale for the plotting sheet; the special study of reefs, shoals and channels. Instructions are given regarding the use of the wire-drag. Several paragraphs are devoted to the smooth plotting of the sheets and the simplified conventional field symbols used for this purpose; to the checking and inspection of boat sheets. At the end of the chapter is a description of the LIETZ rotary brake sounding machine, improved type, the TANNER sounding machine, navigational type, the WEUBLE electric sounding machine and the SIGSBEE deep-sea sounding machine. There is also a general description of echo sounding apparatus.

In Chapter V, devoted to tides and currents, there is first a discussion of the choice of sites of the tidal stations. The Manual then gives a description of the automatic recording tide gauges, Coast and Geodetic Survey type, the method of installation and the daily check on operation. General information is given regarding the various tidal anomalies. The Manual then gives the methods of tabulating the data and the inscriptions for high and low waters for a

detailed study of the tidal phenomena. Reference is made to the various publications of the U.S. Coast and Geodetic Survey; the International Hydrographic Bureau; the Tidal Institute of Liverpool; and various French, German and Dutch publications on the subject of tides.

For the study of currents, after a general description of tidal streams, the Manual describes the method of measurement, either by means of floats or by means of recording apparatus which we have mentioned above.

In the chapter devoted to base-line measurement, a number of practical hints are given for the establishment of the base either by means of the flat tape or by suspended tapes. The corrections for reduction to mean sea level are also developed.

Chapter VII, devoted to triangulation, opens with the conventional definitions of the various orders of triangulation developed in 1925 by the Federal Board of Surveys and Maps. The Manual then describes the precautions to be taken in establishing the programme of observations and in observations from the towers. Examples are given of the solutions of the triangles, quadrilaterals and polygons with or without central point. More detailed information is given, together with samples of the calculations regarding all problems treated in this chapter, in a Supplement prepared in 1936 by the U.S. Hydrographic Office entitled: *Short Course in Computations*, which constitutes an annex to the Manual.

Chapter VIII of the Manual is devoted to trigonometrical levelling and contains some interesting refraction tables.

Chapter IX is devoted to the determination of Azimuth and Time. Special tables are given for several of the circumpolar stars ordinarily used in the azimuth determinations in geodetic surveys. The chapter describes the various methods of calculating the time, either by meridian transits, star altitude observations, by the method of equal altitudes or derived methods, such as the method of GAUSS and that of STACHEBT. In this chapter is also a description of the method of calculating the time by horizontal angles taken with the aid of a theodolite which was developed in the United States Naval Surveys in 1923.

Chapter X gives an outline of magnetic measurements which are sometimes specified in naval surveys, adapted to modern instruments available since 1936, i.e. the Kew magnetometer for the measurement of the magnetic declination and the horizontal component of the terrestrial field, and the dip circle for the third magnetic element.

Chapter XI, relative to the latitude determinations, refers to the U.S. Naval Observatory's *Manual of Field Astronomy*, for the determinations with instruments of precision. The sole methods described in the Manual are the methods employing the sextant, the artificial horizon for the two star equal altitude method due to CANETE DEL PINAR; the horizontal angle method with repeating theodolite and comprising a special choice of stars for observations near the time of maximum elongation. For this purpose tables are given in the Manual for finder altitudes, azimuths and hour angles at elongation. In the third place there is given the BESSEL method for transits near the prime vertical either by both transits of the same star or by transits of two stars (DÖLLEN).

Chapter XII is devoted to the plotting of the smooth sheets. In it are discussed the size and quality of paper for the smooth sheets; the method of establishing the grids, using the polyconic projections according to the tables published by the U.S. Coast and Geodetic Survey. There is discussed also everything referring to the field sheets, the photographs, sounding books, computation notebooks, etc., used for the compilation. Once all the data have been entered, a final check on the hydrography is made to insure that no detail in the sounding books and boat sheets has been overlooked. A similar check is carried out with regard to the coast line with the aid of aerial photographs, which yield abundant detail for cartography, especially with regard to the shore line contours bordered by mangroves, the shape of the headlands, buildings or remarkable features. The ultimate compilation of the sheets is made under the supervision of the Hydrographic Office.

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