CHAPTER 29

HYDROGRAPHY

2900. Introduction

Hydrography is the science of measurement and description of the features which affect marine navigation, including water depths, shorelines, tides, currents, bottom types, and undersea obstructions. Cartography transforms the scientific data collected by hydrographers into data usable by the mariner, and is the final step in a long process which leads from raw data to a usable chart.

The mariner, in addition to being the primary user of hydrographic data, is also an important source of data used in the production and correction of nautical charts. This chapter discusses the processes involved in producing a nautical chart, whether in digital or paper form, from the initial planning of a hydrographic survey to the final printing. It is important to note that digital charts are no more accurate than the paper charts and other sources from which they are produced. "Digital" does not mean "more accurate," for in most cases the digitized data comes from the same sources that the paper charts use.

With this information, the mariner can better understand the information presented on charts, evaluate hydrographic information which comes to his attention, and report discrepancies in a form that will be most useful to charting agencies.

BASICS OF HYDROGRAPHIC SURVEYING

2901. Planning the Survey

The basic sources of data used to produce nautical charts are hydrographic surveys. Much additional information is included, but the survey is central to the compilation of a chart. A survey begins long before actual data collection starts. Some elements which must be decided are:

- Exact area of the survey.
- Type of survey (reconnaissance or standard), scaled to meet standards of charts to be produced.
- Scope of the survey (short or long term).
- Platforms available (ships, launches, aircraft, leased vessels, cooperative agreements).
- Support work required (aerial or satellite photography, geodetics, tides).
- Limiting factors (budget, politics, geographic or operational constraints, positioning system limitations, logistics).

Once these issues are decided, all information available in the survey area is reviewed. This includes aerial photography, satellite data, topographic maps, existing nautical charts, geodetic information, tidal information, and anything else affecting the survey. The survey planners then compile sound velocity information, climatology, water clarity data, any past survey data, and information from light lists, *Sailing Directions*, and *Notices to Mariners*. Tidal information is thoroughly reviewed and tide gauge locations chosen. Local vertical control data is reviewed to see if it meets the expected accuracy standards so the tide gauges can be linked to the vertical datum used for the survey. Horizontal control is reviewed to check for accuracy and discrepancies and to determine sites for local positioning systems to be used in the survey.

Line spacing refers to the distance between tracks to be run by the survey vessel. It is chosen to provide the best coverage of the area using the equipment available. Line spacing is a function of the depth of water, the sound footprint of the collection equipment to be used, and the complexity of the bottom. Once line spacing is chosen, the hydrographer can compute the total miles of survey track to be run and have an idea of the time required for the survey, factoring in the expected weather and other possible delays. The scale of the survey, orientation to the shorelines in the area, and the method of positioning determine line spacing. Planned tracks are laid out so that there will be no gaps between sound lines and sufficient overlaps between individual survey areas.

Wider lines are run at right angles to the primary survey development to verify data repeatability. These are called **cross check lines**.

Other tasks to be completed with the survey include bottom sampling, seabed coring, production of sonar pictures of the seabed, gravity and magnetic measurements (on deep ocean surveys), and sound velocity measurements in the water column.

2902. Echo Sounders in Hydrographic Surveying

Echo sounders were developed in the early 1920s, and compute the depth of water by measuring the time it takes for a pulse of sound to travel from the source to the sea bottom and return. A device called a **transducer** converts electrical energy into sound energy and vice versa. For basic hydrographic surveying, the transducer is mounted permanently in the bottom of the survey vessel, which then follows the planned trackline, generating soundings along the track.

The major difference between different types of echo sounders is in the frequencies they use. Transducers can be classified according to their beam width, frequency, and power rating. The sound radiates from the transducer in a cone, with about 50% actually reaching to sea bottom. **Beam width** is determined by the frequency of the pulse and the size of the transducer. In general, lower frequencies produce a wider beam, and at a given frequency, a smaller transducer will produce a wider beam. Lower frequencies also penetrate deeper into the water, but have less resolution in depth. Higher frequencies have greater resolution in depth, but less range, so the choice is a trade-off. Higher frequencies also require a smaller transducer. A typical low frequency transducer operates at 12 kHz and a high frequency one at 200 kHz.

The formula for depth determined by an echo sounder is:

$$D = \frac{V \times T}{2} + K + D_r$$

where D is depth from the water surface, V is the average velocity of sound in the water column, T is round-trip time for the pulse, K is the system index constant, and D_r is the depth of the transducer below the surface (which may not be the same as vessel draft). V, D_r, and T can be only generally determined, and K must be determined from periodic calibration. In addition, T depends on the distinctiveness of the echo, which may vary according to whether the sea bottom is hard or soft. V will vary according to the density of the water, which is determined by salinity, temperature, and pressure, and may vary both in terms of area and time. In practice, average sound velocity is usually measured on site and the same value used for an entire survey unless variations in water mass are expected. Such variations could occur in areas of major currents or river outflows. While V is a vital factor in deep water surveys, it is normal practice to reflect the echo sounder signal off a plate suspended under the ship at typical depths for the survey areas in shallow waters. The K parameter, or index constant, refers to electrical or mechanical delays in the circuitry, and also contains any constant correction due to the change in sound velocity between the upper layers of water and the average used for the whole project. Further, vessel speed is factored in and corrections are computed for settlement and squat, which affect transducer depth. Vessel roll, pitch, and heave are also accounted for. Finally, the observed tidal data is recorded in order to correct the soundings during processing.

Tides are accurately measured during the entire survey so that all soundings can be corrected for tide height and thus reduced to the chosen vertical datum. Tide corrections eliminate the effect of the tides on the charted waters and ensure that the soundings portrayed on the chart are the minimum available to the mariner at the sounding datum. Observed, not predicted, tides are used to account for both astronomically and meteorologically induced water level changes during the survey.

2903. Collecting Survey Data

While sounding data is being collected along the planned tracklines by the survey vessel(s), a variety of other related activities are taking place. A large-scale **boat sheet** is produced with many thousands of individual soundings plotted. A complete navigation journal is kept of the survey vessel’s position, course and speed. Side-scan sonar may be deployed to investigate individual features and identify rocks, wrecks, and other dangers. Divers may also be sent down to investigate unusual objects. Time is the single parameter which links the ship’s position with the various echograms, sonograms, journals, and boat sheets that make up the hydrographic data package.

2904. Processing Hydrographic Data

During processing, echogram data and navigational data are combined with tidal data and vessel/equipment corrections to produce **reduced soundings**. This reduced data is combined on a plot of the vessel’s actual track with the boat sheet data to produce a **smooth sheet**. A contour overlay is usually made to test the logic of all the data shown. All anomolous depths are rechecked in either the survey records or in the field. If necessary, sonar data are then overlayed to analyze individual features as related to depths. It may take dozens of smooth sheets to cover the area of a complete survey. The smooth sheets are then ready for cartographers, who will choose representative soundings manually or using automated systems from thousands shown, to produce a nautical chart. Documentation of the process is such that any individual sounding on any chart can be traced back to its original uncorrected value. See Figure 2904.

The process is increasingly computerized, such that all the data from an entire survey can be collected and reduced to a selected set of soundings ready for incorporation into an electronic chart, without manual processes of any kind. Only the more advanced maritime nations have this capability, but less developed nations often borrow advanced technology from them under cooperative hydrographic agreements.

2905. Automated Hydrographic Surveying

The evolution of echo sounders has followed the same

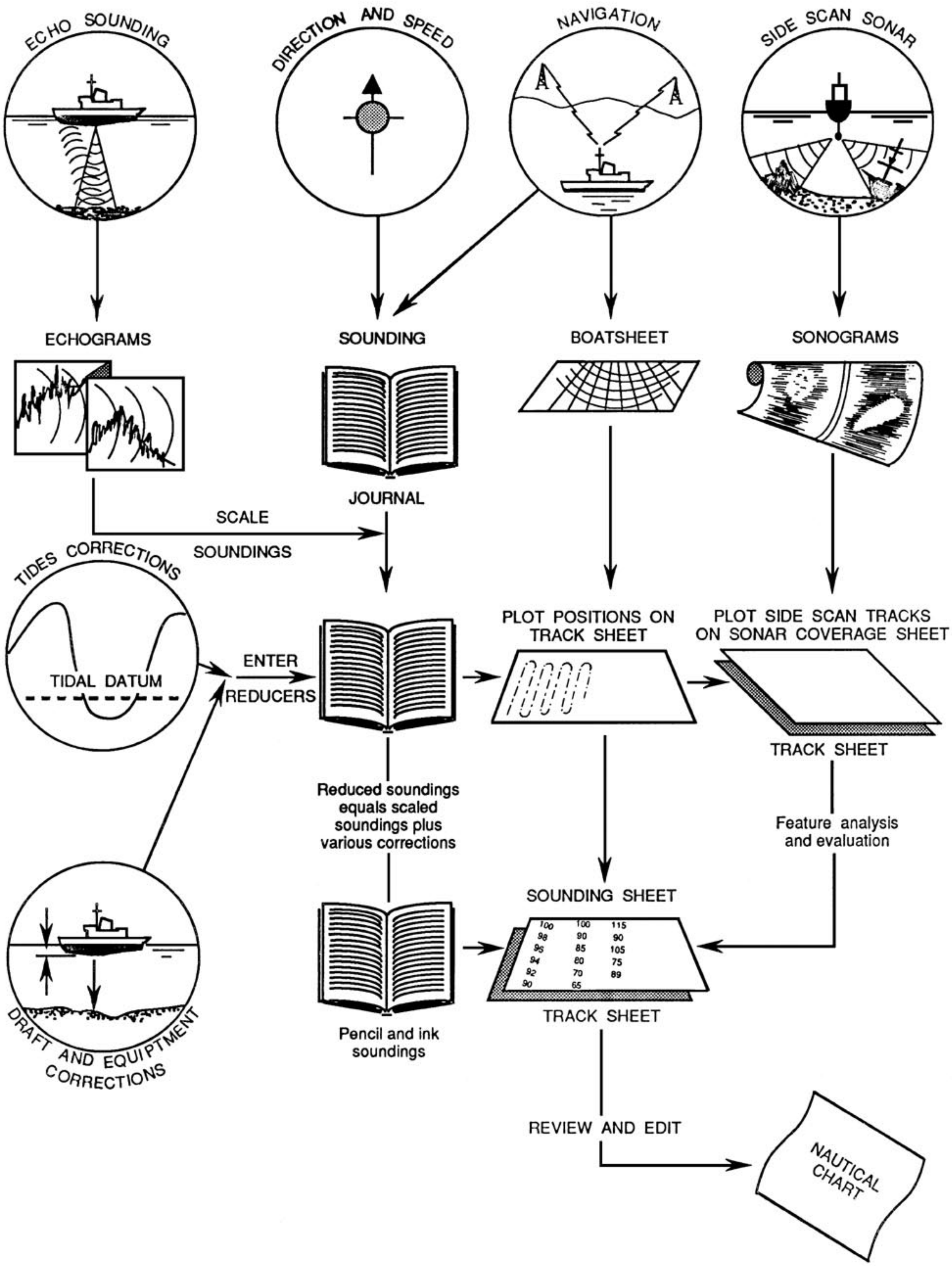

Figure 2904. The process of hydrographic surveying.

pattern of technological innovation seen in other areas. In the 1940s low frequency/wide beam sounders were developed for ships to cover larger ocean areas in less time with some loss of resolution. Boats used smaller sounders which usually required visual monitoring of the depth. Later, narrow beam sounders gave ship systems better resolution using higher frequencies, but with a corresponding loss of area. These were then combined into dual-frequency systems. All echo sounders, however, used a single transducer, which limited surveys to single lines of soundings. For boat equipment, automatic recording became standard.

The last three decades have seen the development of multiple-transducer, multiple-frequency sounding systems which are able to scan a wide area of seabed. Two general types are in use. Open waters are best surveyed using an array of transducers spread out athwartships across the hull of the survey vessel. They may also be deployed from an array towed behind the vessel at some depth to eliminate corrections for vessel heave, roll, and pitch. Typically, as many as 16 separate transducers are arrayed, sweeping an arc of 90°. The area covered by these **swath survey systems** is thus a function of water depth. See Figure 2905. In shallow water, track lines must be much closer together than in deep water. This is fine with hydrographers, because shallow waters need more closely spaced data to provide an accurate portrayal of the bottom on charts. The second type of multiple beam system uses an array of vertical beam transducers rigged out on poles abeam the survey vessel with transducers spaced to give overlapping coverage for the general water depth. This is an excellent configuration for very shallow water, providing very densely spaced soundings from which an accurate picture of the bottom can be made for harbor and small craft charts. The width of the swath of this system is fixed by the distance between the two outermost transducers and is not dependent on water depth.

Airborne Laser Hydrography (ALH) uses laser light to conduct hydrographic surveys from aircraft. It is particularly suitable in areas of complex hydrography containing numerous rocks, shoals, and obstructions dangerous to survey vessels. The technology has developed and matured since the 1970's, and in some areas of the world up to 50% of the hydrographic surveying is done with lasers. Survey rates of some 65 square km per hour are possible, at about a quarter of the cost of comparable vessel surveys. Data density is variable, ranging down to some 1-2 meters square, and depths from one half to over 70 meters have been successfully surveyed.

The technology uses laser light generators mounted in the bottom of a fixed or rotary wing aircraft. Two colors are used, one which reflects off the surface of the sea and back to the aircraft, and a different color which penetrates to the seabed before reflecting back to the aircraft. The difference in the time of reception of the two beams is a function of the water depth. This data is correlated with position data obtained from GPS, adjusted for tides, and added to a bathymetric database from which subsets of data are drawn for compilation of nautical charts.

Obviously water clarity has a great deal to do with the success of ALH, but even in most areas of murky water, seasonal or meteorological variations often allow sufficient penetration of the laser to conduct surveys. Some 80% of the earth's shallow waters are suitable for ALH.

In addition to hydrographic uses, ALH data finds application in coastal resource management, maritime boundaries, environmental studies, submarine pipeline construction, and oil and gas exploration.

HYDROGRAPHIC REPORTS

2906. Chart Accuracies

The chart resulting from a hydrographic survey can be no more accurate than that survey; the survey's accuracy, in turn, is limited by the positioning system used. For many older charts, the positioning system controlling data collection involved using two sextants to measure horizontal angles between surveyed points established ashore. The accuracy of this method, and to a lesser extent the accuracy of modern, shore based electronic positioning methods, deteriorates rapidly with distance. In the past this often determined the maximum scale which could be considered for the final chart. With the advent of the Global Positioning System (GPS) and enhancements such as DGPS and WAAS, the mariner can often now navigate with greater accuracy than could the hydrographic surveyor who collected the chart's source data. Therefore, one must exercise care not to take shoal areas or other hazards closer aboard than necessary because they may not be exactly where they are charted. This is especially true in less-travelled waters.

This is in addition to the caution the mariner must exercise to be sure that his navigation system and chart are on the same datum. The potential danger to the mariner increases with digital charts because by zooming in, he can increase the chart scale beyond what can be supported by the source data. The constant and automatic update of the vessel's position on the chart display can give the navigator a false sense of security, causing him to rely on the accuracy of a chart when the source data from which the chart was compiled cannot support the scale of the chart displayed.

2907. Navigational and Oceanographic Information

Mariners at sea, because of their professional skills and location, represent a unique data collection capability unobtainable by any government agency. Provision of high quality navigational and oceanographic information by government agencies requires active participation by mariners in data collection and reporting. Examples of the type of information required are reports of obstructions, shoals or

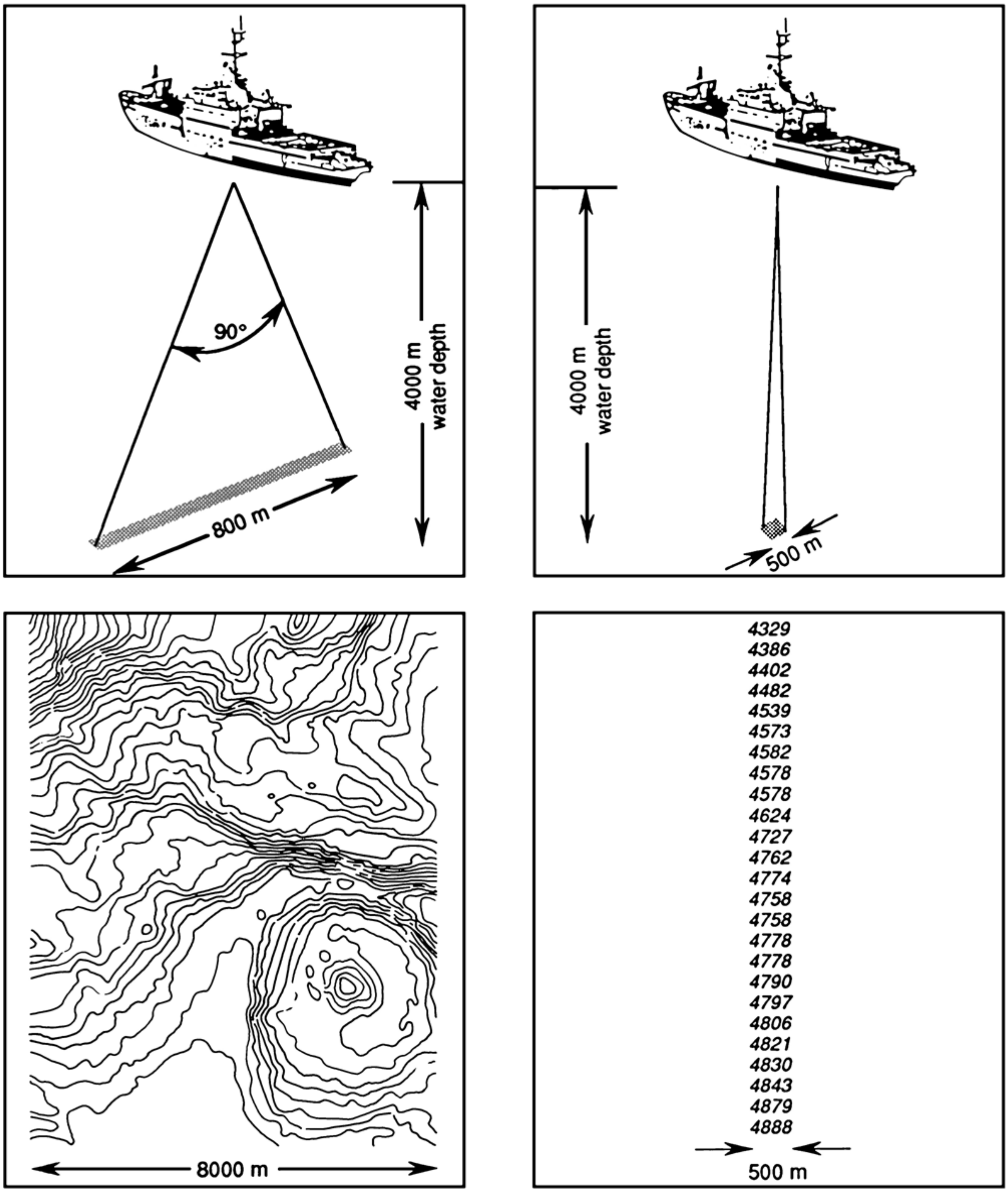

Figure 2905. Swath versus single-transducer surveys.

hazards to navigation, unusual sea ice or icebergs, unusual soundings, currents, geophysical phenomena such as magnetic disturbances and subsurface volcanic eruptions, and marine pollution. In addition, detailed reports of harbor conditions and facilities in both busy and out-of-the-way ports and harbors helps charting agencies keep their products current. The responsibility for collecting hydrographic data by U.S. Naval vessels is detailed in various directives and instructions. Civilian mariners, because they often travel to a wider range of ports, also have an opportunity to contribute substantial amounts of valuable information.

2908. Responsibility for Information

The National Imagery and Mapping Agency (NIMA), the U.S. Naval Oceanographic Office (NAVOCEANO), the U.S. Coast Guard and NOAA's Coast and Geodetic Survey (C&GS) are the primary agencies which receive, process, and disseminate marine information in the U.S.

NIMA produces charts, *Notice to Mariners*, and other nautical materials for the U.S. military services and for navigators in general for waters outside the U.S.

NAVOCEANO conducts hydrographic and oceanographic surveys of primarily foreign or international waters, and disseminates information to naval forces, government agencies, and civilians.

The Coast and Geodetic Survey (C&GS) conducts hydrographic and oceanographic surveys and provides charts for marine and air navigation in the coastal waters of the United States and its territories.

The U.S. Coast Guard is charged with protecting safety of life and property at sea, maintaining aids to navigation, law enforcement, and improving the quality of the marine environment. In the execution of these duties, the Coast Guard collects, analyzes, and disseminates navigational and oceanographic data.

Modern technology allows navigators to easily contribute to the body of hydrographic and oceanographic information.

Navigational reports are divided into four categories:

1. Safety Reports
2. Sounding Reports
3. Marine Data Reports
4. Port Information Reports

The seas and coastlines continually change through the actions of man and nature. Improvements realized over the years in the nautical products published by NIMA, the National Ocean Service (NOS), and U.S. Coast Guard have been made possible in part by the reports and constructive criticism of seagoing observers, both naval and merchant marine. NIMA and NOS continue to rely to a great extent on the personal observations of those who have seen the changes and can compare charts and publications with actual conditions. In addition, many ocean areas and a significant portion of the world's coastal waters have never been adequately surveyed for the purpose of producing modern nautical charts.

Information from all sources is evaluated and used in the production and maintenance of NIMA, NOS and Coast Guard charts and publications. Information from surveys, while originally accurate, is subject to continual change. As it is impossible for any hydrographic office to conduct continuous worldwide surveys, U.S. charting authorities depend on reports from mariners to provide a steady flow of valuable information from all parts of the globe.

After careful analysis of a report and comparison with all other data concerning the same area or subject, the organization receiving the information takes appropriate action. If the report is of sufficient urgency to affect the immediate safety of navigation, the information will be broadcast as a SafetyNET or NAVTEX message. Each report is compared with others and contributes in the compilation, construction, or correction of charts and publications. It is only through the constant flow of new information that charts and publications can be kept accurate and up-to-date.

2909. Safety Reports

Safety reports are those involving navigational safety which must be reported and disseminated by message. The types of dangers to navigation which will be discussed in this article include ice, floating derelicts, wrecks, shoals, volcanic activity, mines, and other hazards to shipping.

1. Ice—Mariners encountering ice, icebergs, bergy bits, or growlers in the North Atlantic should report to Commander, International Ice Patrol, Groton, CT through a U.S. Coast Guard Communications Station. Direct printing radio teletype (SITOR) is available through USCG Communications Stations Boston or Portsmouth.

Satellite telephone calls may be made to the Ice Patrol office in Groton, Connecticut throughout the season at (203) 441-2626 (Ice Patrol Duty Officer). Messages can also be sent through the Coast Guard Operations Center, Boston at (617) 223-8555.

When sea ice is observed, the concentration, thickness, and position of the leading edge should be reported. The size, position, and, if observed, rate and direction of drift, along with the local weather and sea surface temperature, should be reported when icebergs, bergy bits, or growlers are encountered.

Ice sightings should also be included in the regular synoptic ship weather report, using the five-figure group following the indicator for ice. This will assure the widest distribution to all interested ships and persons. In addition, sea surface temperature and weather reports should be made to COMINTICEPAT every 6 hours by vessels within latitude 40°N and 52°N and longitude 38°W and 58°W, if a routine weather report is not made to METEO Washington.

2. Floating Derelicts—All observed floating and drifting dangers to navigation that could damage the hull or propellers of a vessel at sea should be immediately reported by radio. The report should include a brief description of the danger, the date, time (GMT) and the location as exactly as can be determined (latitude and longitude).

3.Wrecks/Man-Made Obstructions—Information is needed to assure accurate charting of wrecks, man-made obstructions, other objects dangerous to surface and submerged navigation, and repeatable sonar contacts that may be of interest to the U.S. Navy. Man-made obstructions not in use or abandoned are particularly hazardous if unmarked and should be reported immediately. Examples include abandoned wellheads and pipelines, submerged platforms and pilings, and disused oil structures. Ship sinkings, strandings, disposals, or salvage data are also reportable, along with any large amounts of debris, particularly metallic.

Accuracy, especially in position, is vital. Therefore, the date and time of the observation, as well as the method used in establishing the position, and an estimate of the fix accuracy should be included. Reports should also include the depth of water, preferably measured by soundings (in fathoms or meters). If known, the name, tonnage, cargo, and cause of casualty should be provided.

Data concerning wrecks, man-made obstructions, other sunken objects, and any salvage work should be as complete as possible. Additional substantiating information is encouraged.

4. Shoals—When a vessel discovers an uncharted or erroneously charted shoal or an area that is dangerous to navigation, all essential details should be immediately reported to NIMA NAVSAFETY BETHESDA MD via radio. An uncharted depth of 300 fathoms or less is considered an urgent danger to submarine navigation. Immediately upon receipt of any message reporting dangers to navigation, NIMA may issue an appropriate NAVAREA warning. The information must appear on published charts as “reported” until sufficient substantiating evidence (i.e. clear and properly annotated echograms and navigation logs, and any other supporting information) is received.

Therefore, originators of shoal reports are requested to verify and forward all substantiating evidence to NIMA at the earliest opportunity. Clear and properly annotated echograms and navigation logs are especially important in verifying or disproving shoal reports.

5. Volcanic Activity—On occasion, volcanic eruptions may occur beneath the surface of the water. These submarine eruptions may occur more frequently and be more widespread than has been suspected in the past. Sometimes the only evidence of a submarine eruption is a noticeable discoloration of the water, a marked rise in sea surface temperature, or floating pumice. Mariners witnessing submarine activity have reported steams with a foul sulfurous odor rising from the sea surface, and strange sounds heard through the hull, including shocks resembling a sudden grounding. A subsea volcanic eruption may be accompanied by rumbling and hissing as hot lava meets the cold sea.

In some cases, reports of discolored water at the sea surface have been investigated and found to be the result of newly formed volcanic cones on the sea floor. These cones can grow rapidly and within a few years constitute a hazardous shoal.

It is imperative that mariners report evidence of volcanic activity immediately to NIMA by message. Additional substantiating information is encouraged.

6. **Mines**—All mines or objects resembling mines should be considered armed and dangerous. An immediate radio report to NIMA should include (if possible):

1. Greenwich Mean Time (UT) and date
2. Position of mine, and how near it was approached
3. Size, shape, color, condition of paint, and presence of marine growth
4. Presence or absence of horns or rings
5. Certainty of identification

2910. Instructions for Safety Report Messages

The International Convention for the Safety of Life at Sea (1974), which is applicable to all U.S. flag ships, states “The master of every ship which meets with dangerous ice, dangerous derelict, or any other direct danger to navigation, or a tropical storm, or encounters subfreezing air temperatures associated with gale force winds causing severe ice accretion on superstructures, or winds of force 10 or above on the Beaufort scale for which no storm warning has been received, is bound to communicate the information by all means at his disposal to ships in the vicinity, and also to the competent authorities at the first point on the coast with which he can communicate.”

The transmission of information regarding ice, derelicts, tropical storms, or any other direct danger to navigation is obligatory. The form in which the information is sent is not obligatory. It may be transmitted either in plain language (preferably English) or by any means of International Code of Signals (wireless telegraphy section). It should be sent to all vessels in the area and to the first station with which communication can be made, with the request that it be transmitted to the appropriate authority. A vessel will not be charged for radio messages to government authorities reporting dangers to navigation.

Each radio report of a danger to navigation should answer briefly three questions:

1. What? A description of the object or phenomenon
2. Where? Latitude and longitude
3. When? Greenwich Mean Time (GMT) and date

Examples:

Ice

SECURITE. ICE: LARGE BERG SIGHTED DRIFTING SW AT 0.5 KT 4605N, 4410W, AT 0800 GMT, MAY 15.

Derelicts

SECURITE. DERELICT: OBSERVED WOODEN 25 METER DERELICT ALMOST SUBMERGED AT 4406N, 1243W AT 1530 GMT, APRIL 21.

The report should be addressed to one of the following shore authorities as appropriate:

1. U.S. Inland Waters—Commander of the Local Coast Guard District
2. Outside U.S. Waters—NIMA NAVSAFETY BETHESDA MD

Whenever possible, messages should be transmitted via the nearest government radio station. If it is impractical to use a government station, a commercial station may be used. U.S. government navigational warning messages should invariably be sent through U.S. radio stations, government or commercial, and never through foreign stations. Detailed instructions for reporting via radio are contained in NIMA *Pub. 117, Radio Navigational Aids*.

OCEANIC SOUNDING REPORTS

2911. Sounding Reports

Acquisition of reliable sounding data from all ocean areas of the world is a continuing effort of NIMA, NAVOCEANO, and NOS. There are vast ocean areas where few soundings have ever been acquired. Much of the bathymetric data shown on charts has been compiled from information submitted by mariners. Continued cooperation in observing and submitting sounding data is absolutely necessary to enable the compilation of accurate charts. Compliance with sounding data collection procedures by merchant ships is voluntary, but for U.S. Naval vessels compliance is required under various fleet directives.

2912. Areas Where Soundings are Needed

Prior to a voyage, navigators can determine the importance of recording sounding data by checking the charts for the route. Indications that soundings may be particularly useful are:

1. Old sources listed on source diagram or note
2. Absence of soundings in large areas
3. Presence of soundings, but only along well-defined lines with few or no soundings between tracks
4. Legends such as “Unexplored area”

2913. Fix Accuracy

A realistic goal of open ocean positioning for sounding reports is a few meters using GPS or Loran C. Depths of 300 fathoms or less should always be reported regardless of the fix accuracy. When such depths are uncharted or erroneously charted, they should be reported by message to NIMA NAVSAFETY BETHESDA MD, giving the best available positioning accuracy. Echograms and other supporting information should then be forwarded by mail to NIMA.

The accuracy goal noted above has been established to enable NIMA to create a high quality data base which will support the compilation of accurate nautical charts. It is particularly important that reports contain the navigator’s best estimate of his fix accuracy and that the positioning system being used (GPS, Loran C, etc.) be identified.

2914. False Shoals

Many poorly identified shoals and banks shown on charts are probably based on encounters with the **Deep Scattering Layer (DSL)**, ambient noise, or, on rare occasions, submarine earthquakes. While each appears real enough at the time of its occurrence, a knowledge of the events that normally accompany these incidents may prevent erroneous data from becoming a charted feature.

The DSL is found in most parts of the world. It consists of a concentration of marine life which descends from near the surface at sunrise to an approximate depth of 200 fathoms during the day. It returns near the surface at sunset. Although at times the DSL may be so concentrated that it will completely mask the bottom, usually the bottom return can be identified at its normal depth at the same time the DSL is being recorded.

Ambient noise or interference from other sources can cause erroneous data. This interference may come from equipment on board the ship, from another transducer being operated close by, or from waterborne noise. Most of these returns can be readily identified on the echo sounder records and should cause no major problems. However, on occasion they may be so strong and consistent as to appear as the true bottom.

Finally, a volcanic disturbance beneath the ship or in the immediate vicinity may give erroneous indications of a shoal. The experience has at times been described as similar to running aground or striking a submerged object. Regardless of whether the feature is an actual shoal or a submarine eruption, the positions, date/time, and other information should be promptly reported to NIMA.

2915. Doubtful Hydrographic Data

Navigators are requested to assist in confirming and charting actual shoals and the removal from the charts of doubtful data which was erroneously reported.

The classification or confidence level assigned to doubtful hydrographic data is indicated by the following standard abbreviations:

Abbreviation	*Meaning*
Rep (date)	Reported (year)
E.D.	Existence Doubtful
P.A.	Position Approximate
P.D.	Position Doubtful

Many of these reported features are sufficiently deep that a ship can safely navigate across the area. Confirmation of the existence of the feature will result in proper charting. On the other hand, properly collected and annotated sounding reports of the area may enable cartographers to accumulate sufficient evidence to justify the removal of the erroneous sounding from the database.

2916. Preparation of Sounding Reports

The procedures for preparing sounding reports have been designed to minimize the efforts of the shipboard observers, yet provide essential information. Submission of plotted sounding tracks is not required. Annotated echograms and navigation logs are preferred. The procedure for collecting sounding reports is for the ship to operate a recording echo sounder while transiting an area where soundings are desired. Fixes and course changes are recorded in the log, and the event marker is used to note these events on the echogram. Both the log and echogram can then be sent to NIMA whenever convenient. From this data, the track will be reconstructed and the soundings keyed to logged times.

The following annotations or information should be clearly written on the echogram to ensure maximum use of the recorded depths:

1. **Ship's name**—At the beginning and end of each roll or portion of the echogram.
2. **Date**—Date, noted as local or GMT, on each roll or portion of a roll.
3. **Time**—The echogram should be annotated at the beginning of the sounding run, regularly thereafter (hourly is best), at every scale change, and at all breaks in the echogram record. Accuracy of these time marks is critical for correlation with ship's position.
4. **Time Zone—**Greenwich Mean Time (GMT) should be used if possible. In the event local zone times are used, annotate echogram whenever clocks are reset and identify zone time in use. It is most important that the echogram and navigation log use the same time basis.
5. **Phase or scale changes**—If echosounder does not indicate scale setting on echogram automatically, clearly label all depth phase (or depth scale) changes and the exact time they occur. Annotate the upper and lower limits of the echogram if necessary.

Figure 2916a and Figure 2916b illustrate the data necessary to reconstruct a sounding track. If ship operations dictate that only periodic single ping soundings can be obtained, the depths may be recorded in the Remarks column. Cartographers always prefer an annotated echogram over single soundings. The navigation log is vital to the reconstruction of a sounding track. Without the position information from the log, the echogram is virtually useless.

The data received from these reports is digitized and becomes part of the digital bathymetric data library of NIMA, from which new charts are compiled. Even in areas where numerous soundings already exist, sounding reports allow valuable cross-checking to verify existing data and more accurately portray the sea floor. Keep in mind that many soundings seen on currently issued charts, and in the sounding database used to make digital charts, were taken when navigation was still largely an art. Soundings accurate to modern GPS standards are helpful to our Naval forces and particularly to the submarine fleet, and are also useful to geologists, geophysicists, and other scientific disciplines.

A report of oceanic soundings should contain:

1. All pertinent information about the ship, sounding system, transducer, etc.
2. A detailed Navigation Log
3. The echo sounding trace, properly annotated

Each page of the report should be clearly marked with the ship's name and date, so that it can be identified if it becomes separated. Mail the report to:

NIMA/PTNM
MS D-44
4600 Sangamore Rd.
Bethesda, MD 20816-5003

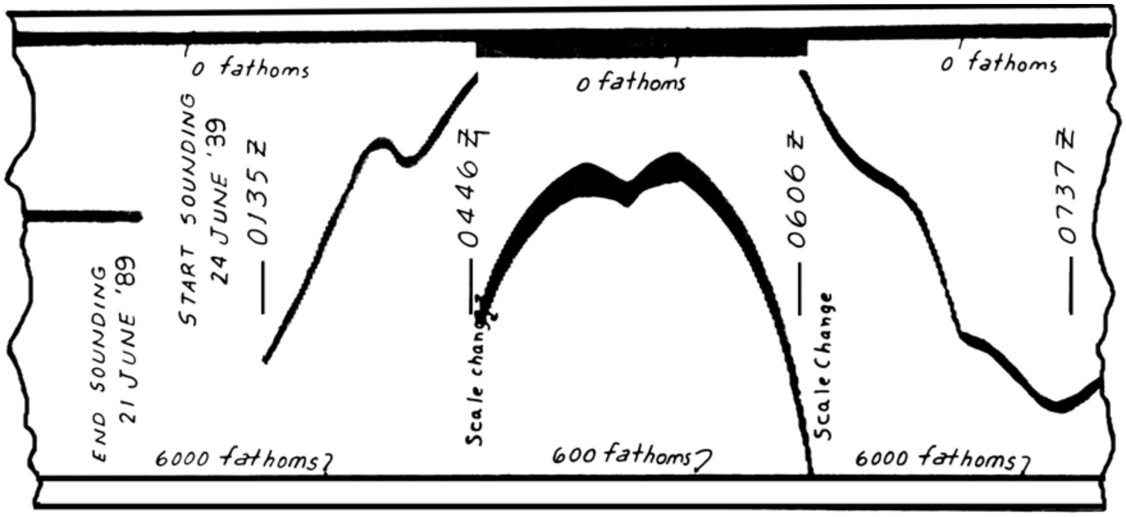

Figure 2916a. Annotated echo sounding record.

NAVIGATION LOG							REMARKS
DATE	TIME (GMT)	LAT.	LONG.	NAV. FIX	COURSE	SPEED	
11/2/83	0221	29°41'N	124°10'E	LORAN	093°	12.3	
	0340				097°	12.3	CHANGE COURSE
	0400	29°40'N	124°35'E	NOON FIX	097°	12.3	
	0728	29°35'N	125°22'E	LORAN	097°	12.3	
	0810				VARIOUS	8.2	REDUCE SPEED – MANUVERING TO AVOID FISHING BOATS
	0826	29°34'N	125°35.5'E	LORAN	097°	12.3	RESUME COURSE AND SPEED
	1011	29°32'N	125°56'E	EVENING STARS	097°	12.3	
	1620	29°23'N	127°22'E	LORAN	102°	12.4	CHANGE COURSE
	2230	29°06.2'N	128°48.5'E	RADAR / STAR	102°	12.5	
	2305				102°	10.1	REDUCE SPEED

Figure 2916b. Typical navigation log for hydrographic reporting.

OTHER HYDROGRAPHIC REPORTS

2917. Marine Information Reports

Marine Information Reports are reports of items of navigational interest such as the following:

1. Discrepancies in published information
2. Changes in aids to navigation
3. Electronic navigation reports
4. Satellite navigation reports
5. Radar navigation reports
6. Magnetic disturbances

Any information believed to be useful to charting authorities or other mariners should be reported. Depending on the type of report, certain information is absolutely critical for a correct evaluation. The following general suggestions are offered to assist in reporting information that will be of maximum value:

1. The geographical position included in the report may be used to correct charts. Accordingly, it should be fixed by the most exact method available, and more than one if possible.
2. If geographical coordinates are used to report position, they should be as exact as circumstances permit. Reference should be made to paper charts by number, edition number, and edition date.
3. The report should state the method used to fix the position and an estimate of fix accuracy.
4. When reporting a position within sight of charted objects, the position may be expressed as bearings and ranges from them. Bearings should preferably

be reported as true and expressed in degrees.

5. Always report the limiting bearings from the ship toward the light when describing the sectors in which a light is either visible or obscured. Although this is just the reverse of the form used to locate objects, it is the standard method used on NIMA nautical charts and in light lists.
6. A report prepared by one person should, if possible, be checked by another.

In most cases marine information can be adequately reported on one of the various forms printed by NIMA or NOS. It may be more convenient to annotate information directly on the affected chart and mail it to NIMA. As an example, it may be useful to sketch uncharted or erroneously charted shoals, buildings, or geological features directly on the chart. Appropriate supporting information should also be provided. NIMA forwards reports as necessary to NOS, NAVOCEANO, or U.S. Coast Guard.

Reports by letter or e-mail are just as acceptable as those prepared on regular forms. A letter report will often allow more flexibility in reporting details, conclusions, or recommendations concerning the observation. When reporting on the regular forms, use additional sheets if necessary to complete the details of an observation.

Reports are required concerning any errors in information published on nautical charts or in nautical publications. The reports should be as accurate and complete as possible. This will result in corrections to the information, including the issuance of a *Notice to Mariners* when appropriate.

Report all changes, defects, establishment or discontinuance of navigational aids and the source of the information. Check your report against the *List of Lights, Pub. 117, Radio Navigational Aids,* and the largest scale chart of the area. If a new, uncharted light has been established, report the light and its characteristics in a format similar to that carried in light lists. For changes and defects, report only elements that differ with light lists. If it is a lighted aid, identify by number. Defective aids to navigation in U.S. waters should be reported immediately to the Commander of the local Coast Guard District.

2918. Electronic Navigation System Reports

Electronic navigation systems have become an integral part of modern navigation. Reports on propagation anomalies or any unusual reception while using the electronic navigation system are desired.

Information should include:

1. Type of system
2. Type of antenna
3. Nature and description of the reception
4. Date and time
5. Position of ship
6. Manufacturer and model of receiver

2919. Radar Navigation Reports

Reports of any unusual reception or anomalous propagation by radar systems caused by atmospheric conditions are especially desirable. Comments concerning the use of radar in piloting, with the locations and description of good radar targets, are particularly needed. Reports should include:

1. Type of radar, frequency, antenna height and type.
2. Manufacturer and model of the radar
3. Date, time and duration of observed anomaly
4. Position
5. Weather and sea conditions

Radar reception problems caused by atmospheric parameters are contained in four groups. In addition to the previously listed data, reports should include the following specific data for each group:

1. Unexplained echoes—Description of echo, apparent velocity and direction relative to the observer, and range
2. Unusual clutter—Extent and Sector
3. Extended detection ranges—Surface or airborne target, and whether point or distributed target, such as a coastline or landmass
4. Reduced detection ranges—Surface or airborne target, and whether point or distributed target, such as a coastline or landmass

2920. Magnetic Disturbances

Magnetic anomalies, the result of a variety of causes, exist in many parts of the world. NIMA maintains a record of such magnetic disturbances and whenever possible attempts to find an explanation. A better understanding of this phenomenon can result in more detailed charts which will be of greater value to the mariner.

The report of a magnetic disturbance should be as specific as possible. For instance: “Compass quickly swung 190° to 170°, remained offset for approximately 3 minutes and slowly returned.” Include position, ship’s course, speed, date, and time.

Whenever the readings of the standard magnetic compass are unusual, an azimuth check should be made as soon as possible and this information included in a report to NIMA.

PORT INFORMATION REPORTS

2921. Importance of Port Information Reports

Port Information Reports provide essential information obtained during port visits which can be used to update and improve coastal, approach, and harbor charts as well as nautical publications including *Sailing Directions*, *Coast Pilots*, and *Fleet Guides*. Engineering drawings, hydrographic surveys and port plans showing new construction affecting charts and publications are especially valuable.

Items involving navigation safety should be reported by message or e-mail. Items which are not of immediate urgency, as well as additional supporting information may be submitted by the *Sailing Directions* Information and Suggestion Sheet found in the front of each volume of *Sailing Directions*, or the *Notice to Mariners* Marine Information Report and Suggestion Sheet found in the back of each *Notice to Mariners*. Reports by letter are completely acceptable and may permit more reporting flexibility.

In some cases it may be more convenient and more effective to annotate information directly on a chart and mail it to NIMA. As an example, new construction, such as new port facilities, pier or breakwater modifications, etc., may be drawn on a chart in cases where a written report would be inadequate.

Specific reporting requirements exist for U.S. Navy ships visiting foreign ports. These reports are primarily intended to provide information for use in updating the Navy Port Directories. A copy of the navigation information resulting from port visits should be provided directly to NIMA by including NIMA NAVSAFETY BETHESDA MD as an INFO addressee on messages containing hydrographic information.

2922. What to Report

Coastal features and landmarks are almost constantly changing. What may at one time have been a major landmark may now be obscured by new construction, destroyed, or changed by the elements. *Sailing Directions (Enroute)* and *Coast Pilots* utilize a large number of photographs and line sketches. Photographs, particularly a series of overlapping views showing the coastline, landmarks, and harbor entrances are very useful.

Especially convenient are e-mailed pictures taken with a digital camera. Use the highest resolution possible and e-mail the picture(s) with description of the feature and the exact Lat./Long. where the picture was taken to: navsafety@nima.mil. There is also an increasing need for video clips on VHS or other media of actual entrances to ports and harbors.

The following questions are suggested as a guide in preparing reports on coastal areas that are not included or that differ from the *Sailing Directions* and *Coast Pilots*.

Approach

1. What is the first landfall sighted?
2. Describe the value of soundings, GPS, LORAN, radar and other positioning systems in making a landfall and approaching the coast. Are depths, curves, and coastal dangers accurately charted?
3. Are prominent points, headlands, landmarks, and aids to navigation adequately described in *Sailing Directions* and *Coast Pilots*? Are they accurately charted?
4. Do land hazes, fog or local showers often obscure the prominent features of the coast?
5. Do discolored water and debris extend offshore? How far? Were tidal currents or rips experienced along the coasts or in approaches to rivers or bays?
6. Are any features of special value as radar targets?

Tides and Currents

1. Are the published tide and current tables accurate?
2. Does the tide have any special effect such as river bore? Is there a local phenomenon, such as double high or low water or interrupted rise and fall?
3. Was any special information on tides obtained from local sources?
4. What is the set and drift of tidal currents along coasts, around headlands, among islands, in coastal indentations?
5. Are tidal currents reversing or rotary? If rotary, do they rotate in a clockwise or counterclockwise direction?
6. Do subsurface currents affect the maneuvering of surface craft? If so, describe.
7. Are there any countercurrents, eddies, overfalls, or tide rips in the area? If so, where?

River and Harbor Entrances

1. What is the depth of water over the bar, and is it subject to change? Was a particular stage of tide necessary to permit crossing the bar?
2. What is the least depth in the channel leading from sea to berth?
3. If the channel is dredged, when and to what depth and width? Is the channel subject to silting?
4. What is the maximum draft, length and width of a vessel that can enter port?
5. If soundings were taken, what was the stage of tide? If the depth information was received from other sources, what were they?
6. What was the date and time of water depth observations?

Hills, Mountains, and Peaks

1. Are hills and mountains conical, flat-topped, or of any particular shape?
2. At what range are they visible in clear weather?
3. Are they snowcapped throughout the year?
4. Are they cloud covered at any particular time?
5. Are the summits and peaks adequately charted? Can accurate distances and/or bearings be obtained by sextant, pelorus, or radar?
6. What is the quality of the radar return?

Pilotage

1. Where is the signal station located?
2. Where does the pilot board the vessel? Are special arrangements necessary before a pilot boards?
3. Is pilotage compulsory? Is it advisable?
4. Will a pilot direct a ship in at night, during foul weather, or during periods of low visibility?
5. Where does the pilot boat usually lie?
6. Does the pilot boat change station during foul weather?
7. Describe the radiotelephone communication facilities available at the pilot station or pilot boat. What is the call sign, frequency, and the language spoken?

General

1. What cautionary advice, additional data, and information on outstanding features should be given to a mariner entering the area for the first time?
2. At any time did a question or need for clarification arise while using NIMA, NOS, or Coast Guard products?
3. Were charted land contours useful while navigating using radar? Indicate the charts and their edition numbers.
4. Would it be useful to have radar targets or topographic features that aid in identification or position plotting described or portrayed in the *Sailing Directions* and *Coast Pilots*?

Photographs

Use overlapping photographs to create panoramic views of wide features or areas. On the back of the photograph (negatives should accompany the required information), indicate the camera position by bearing and distance from a charted object if possible, name of the vessel, the date, time of exposure, height of eye (camera) and stage of tide. All features of navigational value should be clearly and accurately identified on an overlay, if time permits. Bearings and distances (from the vessel) of uncharted features identified on the print should be included. If photographs are digital and sent electronically, include this information in the e-mail message and add the photographs as attachments. Digital photographs can be sent via e-mail, on floppy disks or CR-ROM's.

Radarscope Photography

Because of the value of radar as an aid to navigation, NIMA desires radarscope photographs. Guidelines for radar settings for radarscope photography are given in *Pub. 1310, Radar Navigation and Maneuvering Board Manual*. Such photographs, reproduced in the *Sailing Directions* and *Fleet Guides*, supplement textual information concerning critical navigational areas and assist the navigator in correlating the radarscope presentation with the chart. To be of the greatest value, radarscope photographs should be taken at landfalls, sea buoys, harbor approaches, major turns in channels, constructed areas and other places where they will most aid the navigator. Two prints of each photograph are needed; one should be unmarked, the other annotated.

Examples of desired photographs are images of fixed and floating navigational aids of various sizes and shapes as observed under different sea and weather conditions, and images of sea return and precipitation of various intensities. There should be two photographs of this type of image, one without the use of special anti-clutter circuits and another showing the remedial effects of these. Photographs of actual icebergs, growlers, and bergy bits under different sea conditions, correlated with photographs of their radarscope images are also desired.

Radarscope photographs should include the following annotations:

1. Wavelength
2. Antenna height and rotation rate
3. Range-scale setting and true bearing
4. Antenna type (parabolic, slotted waveguide)
5. Weather and sea conditions, including tide
6. Manufacturer's model identification
7. Position at time of observation
8. Identification of target by *Light List*, *List of Lights*, or chart
9. Camera and exposure data

Other desired annotations include:

1. Beam width between half-power points
2. Pulse repetition rate
3. Pulse duration (width).
4. Antenna aperture (width)
5. Peak power
6. Polarization
7. Settings of radar operating controls, particularly use of special circuits
8. Characteristics of display (stabilized or unstabilized), diameter, etc.

Port Regulations and Restrictions

Sailing Directions (Planning Guides) are concerned with pratique, pilotage, signals, pertinent regulations, warning areas, and navigational aids. The following questions are suggested as a guide to the requested data.

1. Is this a port of entry for overseas vessels?
2. If not a port of entry, where must a vessel go for customs entry and pratique?
3. Where do customs, immigration, and health officials board?
4. What are the normal working hours of officials?
5. Will the officials board vessels after working hours? Are there overtime charges for after-hour services?
6. If the officials board a vessel underway, do they remain on board until the vessel is berthed?
7. Were there delays? If so, give details.
8. Were there any restrictions placed on the vessel?
9. Was a copy of the Port Regulations received from the local officials?
10. What verbal instructions were received from the local officials?
11. What preparations prior to arrival would expedite formalities?
12. Are there any unwritten requirements peculiar to the port?
13. What are the speed regulations?
14. What are the dangerous cargo regulations?
15. What are the flammable cargo and fueling regulations?
16. Are there special restrictions on blowing tubes, pumping bilges, oil pollution, fire warps, etc.?
17. Are the restricted and anchorage areas correctly shown on charts, and described in the *Sailing Directions* and *Coast Pilots*?
18. What is the reason for the restricted areas: gunnery, aircraft operating, waste disposal, etc.?
19. Are there specific hours of restrictions, or are local blanket notices issued?
20. Is it permissible to pass through, but not anchor in, restricted areas?
21. Do fishing boats, stakes, nets, etc., restrict navigation?
22. What are the heights of overhead cables, bridges, and pipelines?
23. What are the locations of submarine cables, their landing points, and markers?
24. Are there ferry crossings or other areas of heavy local traffic?
25. What is the maximum draft, length, and breadth of a vessel that can enter?

Port Installations

Much of the port information which appears in the *Sailing Directions* and *Coast Pilots* is derived from visit reports and port brochures submitted by mariners. Comments and recommendations on entering ports are needed so that corrections to these publications can be made.

If extra copies of local port plans, diagrams, regulations, brochures, photographs, etc. can be obtained, send them to NIMA. It is not essential that they be printed in English. Local pilots, customs officials, company agents, etc., are usually good information sources.

The following list may be used as a check-off list when submitting a letter report:

General

1. Name of the port
2. Date of observation and report
3. Name and type of vessel
4. Gross tonnage
5. Length (overall)
6. Breadth (extreme)
7. Draft (fore and aft)
8. Name of captain and observer
9. U.S. mailing address for acknowledgment

Tugs and Locks

1. Are tugs available or obligatory? What is their power?
2. If there are locks, what is the maximum size and draft of a vessel that can be locked through?

Cargo Handling Facilities

1. What are the capacities of the largest stationary, mobile, and floating cranes available? How was this information obtained?
2. What are the capacities, types, and number of lighters and barges available?
3. Is special cargo handling equipment available (e.g. grain elevators, coal and ore loaders, fruit or sugar conveyors, etc.)?
4. If cargo is handled from anchorage, what methods are used? Where is the cargo loaded? Are storage facilities available there?

Supplies

1. Are fuel oils, diesel oils, and lubricating oils available? If so, in what quantity?

Berths

1. What are the dimensions of the pier, wharf, or basin used?
2. What are the depths alongside? How were they

obtained?
3. Describe berth or berths for working containers or roll-on/roll-off cargo.
4. Does the port have berth for working deep draft tankers? If so, describe.
5. Are both dry and refrigerated storage available?
6. Are any unusual methods used when docking? Are special precautions necessary at berth?

Medical, Consular, and Other Services

1. Is there a hospital or the services of a doctor and dentist available?
2. Is there a United States consulate? Where is it located? If none, where is the nearest?

Anchorages

1. What are the limits of the anchorage areas?
2. In what areas is anchoring prohibited?
3. What is the depth, character of the bottom, types of holding ground, and swinging room available?
4. What are the effects of weather, sea, swell, tides, and currents on the anchorages?
5. Where is the special quarantine anchorage?
6. Are there any unusual anchoring restrictions?

Repairs and Salvage

1. What are the capacities of drydocks and marine railways, if available?
2. What repair facilities are available? Are there repair facilities for electrical and electronic equipment?
3. Are divers and diving gear available?
4. Are there salvage tugs available? What is the size and operating radius?
5. Are any special services (e.g. compass compensation or degaussing) available?

MISCELLANEOUS HYDROGRAPHIC REPORTS

2923. Ocean Current Reports

The set and drift of ocean currents are of great concern to the navigator. Only with the correct current information can the shortest and most efficient voyages be planned. As with all forces of nature, most currents vary considerably with time at a given location. Therefore, it is imperative that NIMA receive ocean current reports on a continuous basis.

The general surface currents along the principal trade routes of the world are well known. However, in other less traveled areas the current has not been well defined because of a lack of information. Detailed current reports from these areas are especially valuable.

An urgent need exists for more inshore current reports along all coasts of the world because data is scarce. Furthermore, information from deep draft ships is needed as this type of vessel is significantly influenced by the deeper layer of surface currents.

The CURRENT REPORT form, NAVOCEANO 3141/6, is designed to facilitate passing information to NAVOCEANO so that all mariners may benefit. The form is self-explanatory and can be used for ocean or coastal current information. Reports by the navigator will contribute significantly to accurate current information for nautical charts, current atlases, *Pilot Charts*, *Sailing Directions* and other special charts and publications.

2924. Route Reports

Route Reports enable NIMA, through its *Sailing Directions (Planning Guides)*, to make recommendations for ocean passages based upon the actual experience of mariners. Of particular importance are reports of routes used by very large ships and from any ship in regions where, from experience and familiarity with local conditions, mariners have devised routes that differ from the “preferred track.” In addition, because of the many and varied local conditions which must be taken into account, coastal route information is urgently needed for updating both *Sailing Directions* and *Coast Pilots*.

A Route Report should include a comprehensive summary of the voyage with reference to currents, dangers, weather, and the draft of the vessel. If possible, each report should answer the following questions and should include any other data that may be considered pertinent to the particular route. All information should be given in sufficient detail to assure accurate conclusions and appropriate recommendations. Some questions to be answered are:

1. Why was the route selected?
2. Were anticipated conditions met during the voyage?