NAVIGATIONAL SAFETY

CHAPTER 27

NAVIGATION PROCESSES

INTRODUCTION

2700. Understanding the Process of Navigation

Navigation is comprised of a number of different processes. Some are done in a set order, some randomly, some almost constantly, others only infrequently. It is in choosing using these processes that an individual navigator's experience and judgment are most crucial. Compounding this subject's difficulty is the fact that there are no set rules regarding the optimum employment of navigational systems and techniques. Optimum use of navigational systems varies as a function of the type of vessel, the quality of the navigational equipment on board, and the experience and skill of the navigator and all the team members.

For the watch officer, ensuring the ship's safety always takes priority over completing operational commitments and carrying out the ship's routine. Navigation is their primary responsibility. Any ambiguity about the position of the vessel which constitutes a danger must be resolved immediately. The best policy is to prevent ambiguity by using all the tools available and continually checking different sources of position information to see that they agree. This includes the routine use of several different navigational techniques, both as operational checks and to maintain skills which might be needed in an emergency. Any single navigational system constitutes a single point of failure, which must be backed up with another source to ensure the safety of the vessel.

It is also the navigator's responsibility to ensure that they and all members of their team are properly trained and ready in all respects for their duties, and that they are familiar with the operation of all gear and systems for which they are responsible. The navigator must also ensure that all digital and/or hardcopy charts and publications are updated with information from the *Notice to Mariners*, and that all essential navigational gear is in operating condition.

Navigating a vessel is a dynamic process. Schedules, missions, and weather often change. Planning a voyage is a process that begins well before the ship gets underway. Executing that plan does not end until the ship ties up at the pier or drops anchor at its final destination. It is rarely possible to over plan a voyage, but it is a more serious error to under plan it. Carefully planning a route, preparing required charts and publications, and using various methods to monitor the ship's position as the trip proceeds are fundamental to safe navigation and are the marks of a professional navigator.

This chapter will examine navigational processes, the means by which a navigator manages all of the resources at their command to ensure a safe and efficient voyage.

BRIDGE RESOURCE MANAGEMENT

2701. The Navigator as Manager

The development of computers and navigational technologies driven by them has led to an evolution, some might say revolution, in the role of the navigator. Increasingly, the navigator is the manager of a combination of systems of varying complexity, which are used to direct the course of the ship and ensure its safety. The navigator is thus becoming less concerned with the direct control of the ship and more concerned with managing the systems and people which do so under their direction. While fundamental navigation skills remain vital, the navigator must become competent and comfortable with the management of advanced technology and human resources, especially in stressful situations.

A modern ship's navigational suite might include an integrated bridge system with a comprehensive fleet and voyage management software package and an ECDIS or ECS system that may replace the ship's paper charts. Many systems can be integrated with the charting systems including AIS, radar overlay, dual interswitched X- and S-band ARPA radars, track or heading control, digital flux gate and ring laser gyrocompasses, GPS/DGPS positioning systems, numerous environmental sensors, a digital depth sounder and a Doppler speed log. The communications suite might include a GMDSS workstation with a NAVTEX receiver, a computer weather routing system, a SATCOM terminal, several installed and portable VHF radios, a closed circuit television system, a public address and alarm system and automated systems controlling cargo and machinery operations. With all this technology coming aboard, crew size is decreasing, placing increased responsibility on each member of the team.

Thus, the modern navigator is becoming a manager of these resources, both electronic and human. Of course, they have always been so, but today's systems are far more complex and the consequences of a navigational error are far more serious than ever before. The prudent navigator will therefore be familiar with the techniques of Bridge Resource Management (BRM), by which they can supervise the numerous complex tasks involved with maintaining navigational control of their vessel.

Bridge Team Management refers to the management of the human resources available to the navigator—helmsman, lookout, engine room watch, etc.—and how to ensure that all members contribute to the goal of a safe and efficient voyage.

Bridge Resource Management (BRM) is the study of the resources available to the navigator and the exploitation of them in order to conduct safe and efficient voyages. The terms "bridge resource management" and "bridge team management" are not precisely defined. For most, bridge resources consist of the complete suite of assets available to the navigator including electronic and human, while bridge team management refers only to human assets, except for the pilot, who is normally not considered a member of the team.

The resources available will vary according to the size of the ship, its mission, its crew, its shoreside management, funding, and numerous other variables. No two vessels are alike in resources, for even if two ships of a single class are alike in every physical respect, the people who man them will be different, and people are the most important resource the navigator has.

Effective Bridge Resource Management requires:

- Clearly defined navigational goals
- Defined procedures—a system—for achieving goals
- Means to achieve the goals
- Measures of progress toward goals
- Constant awareness of the situation tactically, operationally, and strategically
- Clearly defined accountability and responsibility
- Open communication throughout the system
- External support

2702. Watch Conditions

Whenever the navigational situation demands more resources than are immediately available to the navigator, a dangerous condition exists. This can be dealt with in two ways. First, the navigator can call up additional resources, such as by adding a bow lookout or an additional watch officer. Second, they can lower the navigational demands to the point where their available resources are able to cope, perhaps by reducing speed, changing course, heaving to, or anchoring.

Some conditions that increase the demands on the navigator include:

- Fog
- Heavy traffic
- Entering a channel, harbor or restricted area
- Heavy weather
- Fire, flooding, or other emergency

These and many other situations can increase the demands on the time and energy of the navigator, and cause them to need additional resources—another watch officer, a bow lookout, a more experienced helmsman—to take some of the workload and rebalance the amount of work to be done with the people available to do it.

There is no strict legal direction as to the assignment of personnel on watch. Various rules and regulations establish certain factors which must be addressed, but the responsibility for using the available people to meet them rests with the watch officer. Laws and admiralty cases have established certain requirements relating to the position and duties of the lookout, safe speed under certain conditions, mode of steering, and the use of radar. The maritime industry has established certain standards known as **Watch Conditions** to help define the personnel and procedures to be used under various situations:

Watch Condition I indicates unrestricted maneuverability, weather clear, little or no traffic, and all systems operating normally. In this condition, depending on the size and type of vessel and its mission, often a single licensed person can handle the bridge watch.

Watch Condition II applies to situations where visibility is somewhat restricted, and maneuverability is constrained by hydrography and other traffic. This condition may require additional navigational resources, such as a lookout, helmsman, or another licensed watch officer.

Watch Condition III reflects a condition where navigation is seriously constrained by poor visibility, close quarters (as in bays, sounds, or approach channels), and heavy traffic.

Watch Condition IV is the most serious, occurring when visibility is poor, maneuvering is tightly constrained (as in channels and inner harbors), and traffic is heavy.

Any watch condition can change momentarily due to planned or unforeseen events. Emergency drills or actual emergencies on one's own or other nearby vessels can quickly overwhelm the unprepared bridge team. Prudent navigators predict these events, develop plans and train their crews to respond to these events. Training and eternal vigilance are essential to meet unexpected demands.

Under each of these conditions, the navigator must manage their resources effectively and efficiently, calling in extra help when necessary, assigning personnel as needed to jobs for which they are qualified and ready to perform. The navigator must consider the peculiarities of the ship and its people, including considerations of vessel design and handling characteristics, personalities and qualifications of individuals, and the needs of the situation.

2703. Laws Relating to Bridge Resources

Numerous laws and regulations relate to the navigation of ships, particularly in less than ideal conditions. Title 33 of the Code of Federal Regulations (CFR) specifies bridge visibility parameters. Title 46 CFR and IMO standards relate to medical fitness. Public Law 101-380 specifies the maximum hours of work permitted, while 46 CFR specifies the minimum hours of rest required. Competency and certification are addressed by 46 CFR and STCW. Charts, publications, and navigational equipment are the subject of 33 CFR, which also specifies tests required before getting underway and the conduct of ships to prevent collision. This code also requires reporting of certain dangerous conditions aboard the vessel.

Various U.S. state and local regulations also apply to the duties and responsibilities of the bridge team, and numerous regulations and admiralty case law relate indirectly to bridge resource management.

2704. Pilots

One of the navigator's key resources in the harbor and harbor approaches is the pilot, a professional shiphandler with encyclopedic knowledge of a local port and harbor area. Their presence is generally required by local regulation or law. The pilot is not considered, by the common definition, to be a member of the bridge team, but is an extremely important bridge resource and is expected to develop and maintain a cooperative, mutually supportive working relationship with the master and bridge crew. While the pilot is engaged in pilotage duties aboard a vessel in compulsory pilotage waters, the pilot directs the navigation of the vessel, subject to the master's overall command of the ship and the ultimate responsibility for its safety. In this respect, the navigation of the ship in compulsory pilotage waters is a shared responsibility between the pilot and the master/bridge team.

As an important navigational resource, the bridge team should monitor the pilot, and as a professional navigator, the pilot deserves respect. The balance of these two elements is the responsibility of the captain, who manages the **Master-Pilot Exchange (MPX)** for the vessel.

The explicit purpose of the MPX, which is a two-way exchange of information, is for the pilot to provide information about the port and the route to be followed and for the captain to inform the pilot of the particulars of the ship: its draft, condition of engines and navigational equipment and special conditions or characteristics which might affect the ship's close quarters handling. However, simply relating the ship's characteristics and condition does not constitute a proper MPX, which must be more comprehensive.

The implicit purpose of the MPX is to establish an appropriate working relationship between the captain and the pilot, which recognizes that each has an important role in the safe navigation of the vessel. It ensures the agreed upon mental model of the transit is shared with the bridge team. Thus, the MPX is not an event but a process, which will ensure that everyone responsible for navigating the vessel shares the same plan for the transit.

Some ships prepare a pilot card that lists the essential vessel parameters for the pilot's ready reference. The pilot may also use an MPX card to ensure that all required areas of concern are covered. The pilot may or may not require a signature on his own form, and may or may not be requested or allowed to sign ship's forms. These are matters of local law and custom that must be respected

Often, among the pilot’s first words upon boarding will be a recommendation to the captain to take up a certain course and speed. The captain then gives the appropriate orders to the bridge team. As the vessel gathers way, the rest of the MPX can proceed. As time permits, the pilot can be engaged in conversation about the events and hazards to be expected during the transit, such as turning points, shoal areas, weather and tides, other ship traffic, tugs and berthing arrangements, status of ground tackle, and other matters of concern. This information should be shared with the bridge team. At any time during the transit, the captain should bring up matters of concern to the pilot for discussion. Communication is the vital link between pilot and master that ensures a safe transit.

2705. Managing the Bridge Team

Shipboard personnel organization is among the most hierarchical to be found. Orders are given and expected to be obeyed down the chain of command without hesitation or question, especially in military vessels. While this operational style defines responsibilities clearly, it does not take advantage of the entire knowledge base held by the bridge team, which increasingly consists of a number of highly trained people with a variety of skills, abilities, and perceptions.

While the captain may have the explicit right to issue orders without discussion or consultation (and in most routine situations it is appropriate to do so), in unusual, dangerous, and stressful situations, it is often better to consult other members of the team. Communication, up and down, is the glue that holds the bridge team together and ensures that all resources are effectively used. Many serious groundings could have been prevented by the simple exchange of information from crew to captain, information which, for reasons of tradition and mindless obedience to protocol, was not shared or was ignored.

A classic case of failure to observe principles of bridge team management occurred in 1950 when the USS Missouri, fully loaded and making over 12 knots at high tide, grounded hard on Thimble Shoals in Chesapeake Bay. The Captain ignored the advice of his Executive Officer, berated the helmsman for speaking out of turn, and failed to order a right turn into Thimble Shoals Channel. It took more than two weeks to free the ship.

Most transportation accidents are caused by human error, usually resulting from a combination of circumstances, and almost always involving a communications failure. Analysis of numerous accidents across a broad range of transportation fields reveals certain facts about human behavior in a dynamic team environment:

- Better decisions result from input by many individuals
- Success or failure of a team depends on their ability to communicate and cooperate
- More ideas present more opportunities for success and simultaneously limit failure
- Effective teams can share workloads and reduce stress, thus reducing stress-related errors
- All members make mistakes; no one has all the right answers
- Effective teams usually catch mistakes before they happen, or soon after, and correct them

These facts argue for a more inclusive and less hierarchical approach to bridge team management than has been traditionally followed. The captain/navigator should include input from bridge team members when constructing the passage plan and during the pre-voyage conference, and should share his views openly when making decisions, especially during stressful situations. They should look for opportunities to instruct less experienced team members by involving them in debate and decisions regarding the voyage. This ensures that all team members know what is expected and share the same mental model of the transit.

Effective bridge teams do not just happen. They are the result of planning, education, training, practice, drills, open communication, honest responses, and management support. All of these attributes can and should be taught, and a number of professional schools and courses are dedicated to this subject. See Figure 2705 for a link to U.S. Coast Guard approved courses such as Bridge Resource Management and other subjects that will help the navigator manage resources effectively.

Figure 2705. Link to USCG list of courses search engine. http://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/National-Maritime-Center-NMC/Training-Assessments/

2706. Standards of Training, Certification, and Watchkeeping (STCW)

The International Maritime Organization's (IMO) International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) of 1978 set qualification standards for masters, mates, and ratings. It entered into force in 1984, and the United States became a party to this convention in 1991.

Between 1984 and 1992, significant limitations to the 1978 conventions became apparent. Vague requirements, lack of clear standards, limited oversight and control, and failure to address modern issues of watchkeeping were all seen as problems meriting a review of the 1978 agreement. This review was to concentrate on the *human element*, which in fact is the cause of most marine casualties. Three serious maritime casualties, in which human factors played a part, spurred the IMO to expedite this review and update the STCW Convention and Code. This work commenced in 1995 and was subsequently entered into force on February 1, 1997. The STCW Convention and its associated Code, have been amended several times since then, most recently in 2010, resulting in improvements in mariner qualifications.

The provisions of the STCW address the human element of bridge resource management. They mandate maximum working hours, minimum rest periods, and training requirements for specific navigational and communications systems such as ECDIS, ARPA and GMDSS. They require that officers understand and comply with the principles of bridge resource management. They require not merely that people be trained in certain procedures and operations, but that they *demonstrate competence* therein.

The navigational competencies for deck ratings relate to general watchstanding duties. Such personnel must not only complete training, but must demonstrate competency in the use of magnetic and gyro-compasses for steering and course changes, response to standard helm commands, change from automatic to hand steering and back, responsibilities of the lookout, and proper watch relief procedures.

Competence may be demonstrated by various methods either at sea, as part of an approved course, or in approved simulators, and must be documented by Qualified Assessors (QA's).

VOYAGE PLANNING

2707. The Passage Plan

Before each voyage begins, the navigator should develop a detailed mental model of how the entire voyage is to proceed sequentially, from getting underway to mooring. This mental model will include charting courses, forecasting the weather and tides, checking *Sailing Directions* and *Coast Pilots*, and projecting the various future events—landfalls, narrow passages, and course changes—that will transpire during the voyage. This mental model becomes the standard by which they will measure progress toward the goal of a safe and efficient voyage, and it is manifested in a passage plan. See Figure 2707 for a graphic depicting a systems approach to passage planning.

The passage plan is a comprehensive, step by step description of how the voyage is to proceed from berth to berth, including undocking, departure, enroute, approach and mooring at the destination. The passage plan should be communicated to the navigation team in a pre-voyage conference in order to ensure that all members of the team share the same mental model of the entire trip. This differs from the more detailed piloting brief discussed in Chapter 10, though it may be held in conjunction with it, and may be a formal or informal process.

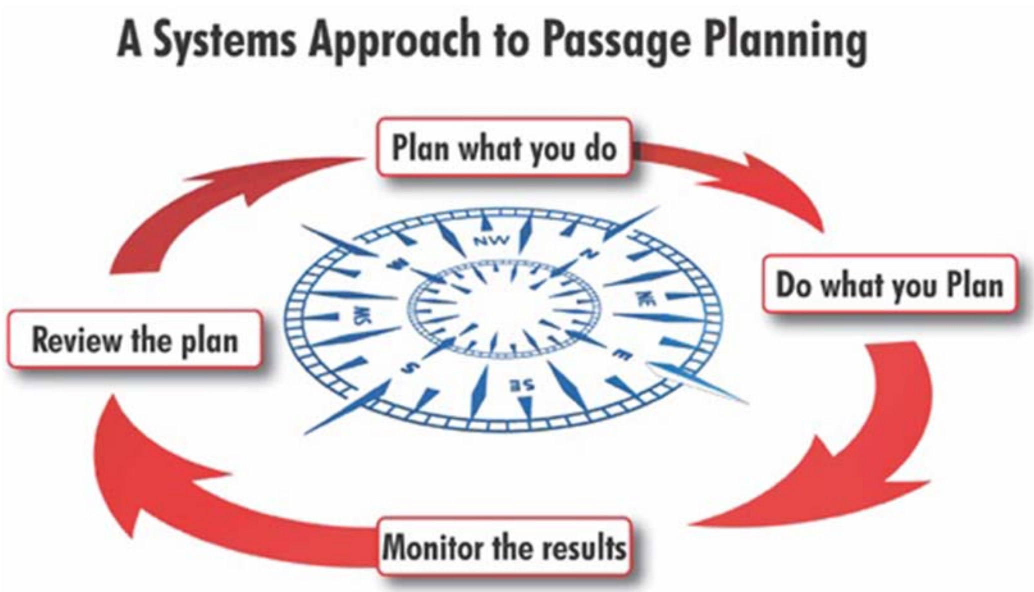

Figure 2707. Passage planning model.

Some COLREG rules leave room for masters and bridge teams to interpret their execution. For example, the close proximity of a passing vessel or the distance that a give-way vessel must clear a stand-on vessel is not defined and differences of opinion must be addressed. One watch officer might consider a one mile minimum passing distance appropriate, while the captain prefers to pass no closer than two miles. These kinds of differences must be reconciled before the voyage begins, and the passage plan is the appropriate forum in which to do so.

Thus, each member of the navigation team will be able to assess the vessel's situation at any time and make a judgment as to whether or not additional bridge resources are necessary. Passage planning procedures are specified in Title 33 of the U.S. Code, IMO Resolutions, and a number of professional books and publications. There are some fifty elements of a comprehensive passage plan depending on the size and type of vessel, each applicable according to the individual situation.

Passage planning software can greatly simplify the process and ensure that nothing important is overlooked. A good passage planning software program will include great circle waypoint/distance calculators, tide and tidal current predictors, celestial navigational calculators, consumables estimators for fuel, oil, water, and stores, and other useful applications.

As the voyage proceeds, the navigator must maintain situational awareness to continually assess the progress of the ship as measured against the passage plan and the mental model of the voyage. Situational awareness consists of perceiving, comprehending, and comparing what is known at any given time with the mental model and passage plan. Both individual and team situational awareness are necessary for a safe voyage, and the former must be established by all members of the bridge team before the latter is possible.

The enemies of situational awareness are complacency, ignorance, personal bias, fatigue, stress, illness, and any other condition which prevents navigators and their team members from clearly seeing and assessing the situation.

2708. Constructing a Voyage Track

Coastwise passages of a few hundred miles or less can be laid out directly on charts, either electronic or paper. Over these distances, it is reasonable to ignore great circle routes and plot voyages directly on Mercator charts.

For trans-oceanic voyages, construct the track using a navigational computer, a great circle (gnomonic) chart, or a sailing chart. It is best to use a navigational computer or calculator if one is available to save time and to eliminate the plotting errors inherent in transferring the track from a gnomonic to a Mercator projection. Because they solve problems mathematically, computers and calculators also eliminate rounding errors inherent in the tables, providing more accurate solutions.

To use a navigational computer for voyage planning, navigators simply enters the two endpoints of their planned voyage or major legs thereof in the appropriate spaces. The program may ask for track segment intervals every X number of degrees. It then computes waypoints along the great circle track between the two endpoints, determines each track leg's distance and, given a speed of advance, calculates the time the vessel can expect to pass each waypoint. The waypoints may be saved as a route, viewed on screen, and sent to the autopilot. On paper charts, construct the track on an appropriate Mercator chart by plotting the computer-generated waypoints and the tracks between them.

After adjusting the track as necessary to pass well clear of any hazard, choose a **speed of advance (SOA)** that ensures the ship will arrive on time at its destination or at any required point. Various factors including scheduled deliveries, rendezvous plans, weather avoidance, fuel efficiency and others can contribute to a planned SOA. If the time of arrival is open-ended, that is, not specifically required, choose a reasonable average SOA. Given an SOA, mark the track with the vessel's first few planned hourly positions. In the Navy, these planned positions are **points of intended movement (PIM)**. The SOA chosen for each track leg is the PIM speed. Merchant vessels usually refer to them as waypoints.

An operation order often assigns a naval vessel to an operating area. In that case, plan a track from the departure to the edge of the operating area to ensure that the vessel arrives at the operating area on time. Following a planned track inside the assigned area may be impossible because of the dynamic nature of an exercise. In that case, carefully examine the entire operating area for navigational hazards. If simply transiting through the area, the ship should still follow a planned and approved track.

2709. Following a Voyage Plan

Complete the planning discussed in section 2708 prior to leaving port. Once the ship is transiting, frequently compare the ship's actual position to the planned position and adjust the ship's course and speed to compensate for any deviations. Order courses and speeds to keep the vessel on track without significant deviation.

Often, a vessel will have its operational commitments changed after it gets underway. If this happens, it will be necessary to begin the voyage planning process anew.

VOYAGE PREPARATION

2710. Equipment Inventory

Prior to getting the ship underway, the navigator should inventory all navigational equipment, charts, and publications. They should develop a checklist of navigational equipment specific to the vessel and check that all required equipment is onboard and in operating order. The navigator should have all applicable *Sailing Directions*, pilot charts, and navigation charts covering the planned route. They should also have all charts and *Sailing Direction*s covering ports at which the vessel may call. They should have all the equipment and publications required to support all appropriate navigational methods. Finally, they must have all technical documentation required to support the operation of the electronic navigation suite. Much of this information may be carried electronically.

It is important to complete this inventory well before the departure date and obtain all missing items before sailing.

2711. Chart Preparation

Just as the navigator must prepare charts for piloting, they must also prepare their small scale charts for an open ocean transit. The following is the minimum chart preparation required for an open ocean or offshore coastal transit. The charts should be reviewed by the vessel master and/or pilot (if taken).

Correcting the Chart: Correct all applicable charts through the latest *Notice to Mariners*, *Local Notice to Mariners*, and Broadcast Notice to Mariners. Ensure the chart to be used is the latest announced edition. If electronic charts are used, ensure the latest chart corrections have been downloaded and that the charting software is installed with the latest manufacturer update.

Plotting the Track: Mark the track course above the track line with a "C" followed by the course. Similarly, mark each track leg's distance under the course line with a

"D" followed by the distance in nautical miles. Figure 2711

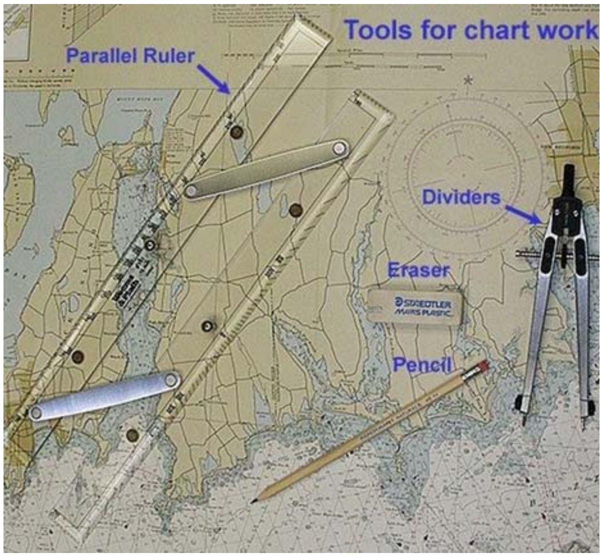

Figure 2711. Typical tools used when navigating on paper charts include a pair of dividers, parallel ruler, eraser and pencil.

depicts some of the plotting tools used when navigating on paper charts.

Calculating Minimum Expected, Danger, and Warning Soundings: Chapter 10 discusses calculating minimum expected, danger and warning soundings. Determining these soundings is particularly important for ships passing a shoal close aboard. Set these soundings to warn the conning officer that they are passing close to the shoal. Mark the minimum expected sounding, the warning sounding, and the danger sounding clearly on the chart and indicate the section of the track for which they are applicable.

Marking Allowed Operating Areas: (Military vessels) Often an operation order assigns a naval vessel to an operating area for a specific period of time. There may be operational restrictions placed on the ship while within this area. For example, a surface ship assigned to an operating area may be ordered not to exceed a certain speed for the duration of an exercise. When assigned an operating area, clearly mark that area on the chart. Label it with the time the vessel must remain in the area and what, if any, operational restrictions it must follow. The conning officer and the captain should be able to glean the entire navigational situation from the chart alone without reference to the directive from which the chart was constructed. Therefore, put all operationally important information directly on the chart.

Marking Chart Shift Points: Mark the chart points where the navigator must shift to the next chart, and note the next chart number.

Examining Either Side of Track: Highlight any shoal water or other navigational hazard near the planned track. This will alert the conning officer as they approach a possible danger.

VOYAGE MONITORING

2712. Fix Frequency

The Coast Guard has allowed ECDIS and specific electronic chart systems (ECS) to meet the chart carriage requirement of CFR Title 33. If ECDIS or ENC is in use, fix frequency is not an issue. The ship's position will be displayed on the chart continuously and the navigator need only monitor the process. If only a chart plotter is available, more careful attention is necessary since a chart plotter cannot substitute for paper charts as ECDIS does. Nevertheless, it is reasonable to plot fixes at less frequent intervals when using a chart plotter, checking the system with a hand-plotted fix at prudent intervals.

Assuming that an electronic chart system is not available and hand-plotted fixes are the order of the day, adjust the fix interval to ensure that the vessel remains at least two fixes from the nearest danger. Choose a fix interval that provides a sufficient safety margin from all charted hazards.

Table 2712 below lists recommended fix intervals as a function of the phase of navigation:

	Harbor/Appr.	Coastal	Ocean
Frequency	3 min. or less	3-15 min.	30 min.

Table 2712. Recommended fix intervals.

Use all available fix information. With the advent of accurate satellite navigational systems, it is especially tempting to disregard this maxim. However, the experienced navigator never feels comfortable relying solely on one particular system. Supplement the satellite position with celestial fixes, radar lines of position, soundings, or visual observations. Evaluate the accuracy of the various fix methods against the satellite position.

Use an inertial navigator if one is available. The inertial navigator may actually produce estimated positions more accurate than non-GPS based fix positions. Inertial navigators are completely independent of any external input. Therefore, they are invaluable for maintaining an accurate ship's position during periods when external fix sources are unreliable or unavailable.

Always check a position determined by a fix, inertial navigator, or DR by comparing the charted sounding at the position with the fathometer reading. If the soundings do not correlate, investigate the discrepancy.

Chapter 9 covers the importance of maintaining a proper DR. It bears repeating here. Determine the difference between the fix and the DR positions at every fix and use this information to calculate an EP from every DR. Constant application of set and drift to the DR is crucial if the vessel must pass a known navigational hazard close aboard.

2713. Fathometer Operations

While the science of hydrography has made tremendous advances in recent years, these developments have yet to translate into significantly more accurate soundings on charts. Further, mariners often misunderstand the concept of an electronic chart, erroneously thinking that the conversion of a chart to electronic format indicates that updated hydrographic information has been used to compile it. This is rarely the case. Newly compiled chart data still may be based on sounding databases, which in some cases are more than a century old.

While busy ports and harbors tend to be surveyed and dredged at regular intervals, in less traveled areas it is common for the navigator to find significant differences between the observed and charted soundings. If in doubt about the date of the soundings, refer to the title block of the chart, where information regarding the data used to compile it may be found.

Standardized rules and procedures for the use of the depth sounder are advisable and prudent. Table 2713 suggests a set of guidelines for depth sounder use on a typical ship.

Water Depth	Sounding Interval
< 10 m	Monitor continuously.
10 m - < 100 m	Every 15 minutes.
100 m - < 300 m	Every 30 minutes.
> 300 m	Every hour.

Table 2713. Fathometer operating guidelines.

2714. Compass Checks

Determine gyro compass error at least once daily and before each transit of restricted waters. Check the gyro compass reading against the inertial navigator if one is installed. If the vessel does not have an inertial navigator, check gyro error using a flux gate magnetic or ring laser gyro compass, or by using the celestial techniques discussed in Chapter 15.

The magnetic compass, if operational, should be adjusted regularly and a deviation table prepared and posted as required (see Chapter 8). If the magnetic compass has been deactivated in favor of a digital flux gate magnetic, ring laser gyro, or other type of electronic compass, the electronic compass should be checked to ensure that it is operating within manufacturer's specifications, and that all remote repeaters are in agreement. Note that the electronic compass must not be in the ADJUST mode when in restricted waters.

2715. Real Time Navigation Data

With the advent of electronic navigation, mariners have access before and during transits to real time observations, forecasts and other geospatial information. This data, accessed through various channels (AIS, NAVTEX, or internet connection) can increase mariner situational awareness and navigation safety. Available data includes tides, currents, water levels, salinity, winds, atmospheric pressure, air and water temperatures.

2716. Night Orders and Standing Orders

The Night Order Book is the vehicle by which the captain informs the officer of the deck of their orders for operating the ship. It may be in hardcopy or electronic format. The Night Order Book, despite its name, can contain orders for the entire 24 hour period for which the Captain or Commanding Officer issues it.

The navigator may write the Night Orders pertaining to navigation. Such orders include assigned operating areas, maximum speeds allowed, required positions with respect to PIM or DR, and, regarding submarines, the maximum depth at which the ship can operate. Each department head should include in the Night Order book the evolutions they want to accomplish during the night that would normally require the captain's permission. The captain can add further orders and directions as required.

The Officer of the Deck or mate on watch must not follow the Night Orders blindly. Circumstances under which the captain signed the Orders may have changed, rendering some evolutions impractical or impossible. The Officer of the Deck, when exercising their judgment on completing ordered evolutions, must always inform the captain of any deviation from the Night Orders as soon as such a deviation occurs.

While Night Orders are in effect only for the 24 hours after they are written, Standing Orders are continuously in force. The captain sets the ship's navigation policy in these orders. They set required fix intervals, intervals for fathometer operations, minimum CPA's, and other general navigation and collision avoidance requirements.

2717. Watch Relief Procedures

When a watch officer relieves as Officer of the Deck or mate on watch, they assume the responsibility for the safe navigation of the ship. They become the Captain's direct representative, and is directly responsible for the safety of the ship and the lives of its crew. They must prepare themselves carefully prior to assuming these responsibilities. A checklist developed specifically for each vessel can serve as a reminder that all watch relief procedures have been followed. The following list contains those items that, as a minimum, the relieving watch officer must check prior to assuming the navigation watch.

- **Conduct a Pre-Watch Tour:** The relieving watch officer should tour the ship prior to their watch. They should familiarize themselves with any maintenance in progress, and check for general cleanliness and stowage. They should see that any loose gear that could pose a safety hazard in rough seas is secured.
- **Check the Position Log and Chart:** Check the type and accuracy of the ship's last fix. Verify that the navigation watch has plotted the last fix properly. Ensure there is a properly constructed DR plot on the chart. Examine the DR track for any potential navigational hazards. Check ship's position with respect to the PIM or DR. Ensure that the ship is in the correct operating area, if applicable. Check to ensure that the navigation watch has properly applied fix expansion if necessary.
- **Check the Fathometer Log:** Ensure that previous watches have taken soundings at required intervals and that the navigation watch took a sounding at the last fix. Verify that the present sounding matches the charted sounding at the vessel's position.
- **Check the Compass Record Log:** Verify that the navigation watch has conducted compass checks at the proper intervals. Verify that gyro error is less than 1° and that all repeaters agree within 1° with the master gyro.
- **Read the Night Orders:** Check the Night Order Book for the captain's directions for the duration of the watch.
- **Check Planned Operations and Evolutions:** For any planned operations or evolutions, verify that the ship meets all prerequisites and that all watchstanders have reviewed the operation order or plan. If the operation is a complicated one, consider holding an operations brief with applicable watchstanders prior to assuming the watch.
- **Check the Broadcast Schedule:** Read any message traffic that could have a bearing on the upcoming watch. Find out when the last safety and operational messages were received. Determine if there are any required messages to be sent during the watch (e.g. position reports, weather reports, AMVER messages).
- **Check the Contact Situation:** Check the radar picture (and sonar contacts if so equipped). Determine which contact has the nearest CPA and what maneuvers, if any, might be required to open the CPA. Find out from the off-going watch officer if there have been any bridge-to-bridge communications with any vessels in the area. Check that no CPA will be less than the minimum set by the Standing Orders.
- **Review Watchstander Logs:** Review the log entries for all watchstanders. Note any out-of-specification readings or any trends in log readings indicating that a system will soon fail.

After conducting these checks, the relieving watch officer should report that they are ready to relieve the watch. The watch officer should brief the relieving watch officer on the following:

- Present course and speed
- Present depth (submarines only)
- Evolutions planned or in progress
- Status of the engineering plant
- Status of any out-of-commission equipment
- Orders not noted in the Night Order Book
- Status of cargo
- Hazardous operations planned or in progress
- Routine maintenance planned or in progress
- Planned ship's drills
- Any individuals working aloft, or in a tank or hold
- Any tank cleaning operations in progress

If the relieving watch officer has no questions following this brief, they should relieve the watch and announce to the rest of the bridge team that they have the deck and the conn. The change of watch should be noted in the ship's deck log.

Care should be taken when bridge team members relieve their perspective posts. Many distractions arise during watch relief and extra precautions should be taken in order to mitigate these risks. At times, staggering the watch relief of multiple watchstanders can provide continuity. Conversely, a unified relief may be the most efficient means to safely transfer the watch. Watch officers should not relieve the watch in the middle of an evolution, when making passing arrangement with another vessel or when casualty procedures are being carried out. This ensures watchstander continuity when carrying out a specific evolution. Alternatively, the on-coming watch officer might relieve only the conn, leaving the deck watch with the off-going officer until the situation is resolved.

2718. Bridge Navigational Watch & Alarm System

The **Bridge Navigational Watch & Alarm System (BNWAS)** is a monitoring and alarm system, which notifies other watch officers or the master of the ship if the office on watch does not respond or becomes incapacitated while on duty.

A series of alerts and alarms are first sounded by BNWAS, on the bridge or wheelhouse, to alert the officer on watch. If there is no response to the alarms, then the system will alert other deck officers, which may include the master, so that someone can come up to the bridge and investigate the situation.

The BNWAS must be operational when a vessel is heading on a voyage unless the master decides otherwise.

CHAPTER 28

EMERGENCY NAVIGATION

BASIC TECHNIQUES OF EMERGENCY NAVIGATION

2800. Planning for Emergencies

Increasing reliance on electronic navigation and communication systems has dramatically changed the perspective of emergency navigation. While emergency navigation once concentrated on long-distance lifeboat navigation, today it is far more likely that navigators will suffer failure of their ship's primary electronic navigation systems than that they will be forced to navigate a lifeboat. In the unlikely event they must abandon ship, their best course of action is to remain as close to the scene as possible, for this is where rescuers will concentrate their search efforts. Leaving the scene of a disaster radically decreases the chance of rescue, and there is little excuse for failure to notify rescue authorities with worldwide communications and maritime safety systems available at little cost. See Chapter 30 on Maritime Safety Systems for further discussion of these systems.

In the event of failure or destruction of electronic systems when the vessel itself is not in danger, navigational equipment and methods may need to be improvised. This is especially true with ECDIS and electronic charts. Navigators of a paperless ship, whose primary method of navigation is ECDIS, must assemble enough backup paper charts, equipment, and knowledge to complete their voyage in the event of a major computer system failure. Navigators who keep a couple of dozen paper charts and a spare handheld GPS receiver under their bunk will be heroes in such an event. If they have a sextant and celestial calculator or tables and the knowledge to use them, so much the better.

No navigator should ever become completely dependent on electronic methods. The navigator who regularly navigates by blindly pushing buttons and reading the coordinates from "black boxes" will not be prepared to use basic principles to improvise solutions in an emergency.

For offshore voyaging, professional navigators should become thoroughly familiar with the theory and practice of celestial navigation. They should be able to identify the most useful stars and know how to solve various types of sights. They should be able to construct a plotting sheet with a protractor and improvise a sextant. They should know how to solve sights using tables or a navigational calculator. For the navigator prepared with such knowledge the situation is never hopeless. Some method of navigation is always available to one who understands certain basic principles.

The modern ship's regular suite of navigation gear consists of many complex electronic systems. Though they may possess a limited backup power supply, most depend on an uninterrupted supply of ship's electrical power. The failure of that power due to breakdown, fire, or hostile action can instantly render the unprepared navigator helpless. This discussion is intended to provide the navigator with the information needed to navigate a vessel in the absence of the regular suite of navigational gear. Training and preparation for a navigational emergency is essential; this should consist of regular practice in the techniques discussed herein.

2801. Emergency Navigation Kit

The navigator should assemble a kit containing equipment for emergency navigation. This kit should contain:

1. At least one proven and personally tested hand-held GPS receiver with waypoints and routes entered, and with plenty of spare batteries.
2. A small, magnetic hand-bearing compass such as is used in small craft navigation, to be used if all other compasses fail.
3. A minimal set of paper charts for the voyage at hand, ranging from small-scale to coastal to approach and perhaps harbor, for the most likely scenarios. A *pilot chart* for the ocean basin in question makes a good small scale chart for offshore use.
4. A notebook or journal suitable for use as a deck log and for computations, plus maneuvering boards, graph paper, and position plotting sheets.
5. Pencils, erasers, a straightedge, protractor or plotter, dividers and compasses, and a knife or pencil sharpener.
6. A timepiece. The optimum timepiece is a quartz crystal chronometer, but any high-quality digital wristwatch will suffice if it is synchronized with the ship's chronometer. A portable radio capable of receiving time signals, together with a good wristwatch, will also suffice.
7. A marine sextant. (An inexpensive plastic sextant will suffice.) Several types are available commercially.

The emergency sextant should be used periodically so its limitations and capabilities are fully understood.

8. A celestial navigation calculator and spare batteries, or a current *Nautical Almanac* and this book or a similar text. Another year's almanac can be used for stars and the Sun without serious error by emergency standards. Some form of long-term almanac might be copied or pasted in the notebook.
9. Tables. Some form of table might be needed for reducing celestial observations if the celestial calculator fails. The *Nautical Almanac* produced by the U.S. Naval Observatory contains detailed procedures for calculator sight reduction and a compact *sight reduction table*.
10. Flashlight. Check the batteries periodically and include extra batteries and bulbs in the kit.
11. Portable radio. A handheld VHF transceiver approved by the Federal Communications Commission for emergency use can establish communications with rescue authorities. A small portable radio may be used as a radio direction finder or for receiving time signals.
12. An Emergency Position Indicating Radiobeacon (EPIRB) and a Search and Rescue Transponder (SART) are absolutely essential (See Chapter 30 on Maritime Safety Systems).
13. Portable handheld satellite telephones, such as those manufactured by Iridium, Inmarsat, Globalstar and others, are now affordable and an invaluable tool to have in your emergency navigation kit.

2802. Most Probable Position

In the event of failure of primary electronic navigation systems, the navigator may need to establish the **most probable position** (MPP) of the vessel. Usually there is little doubt as to the position. The most recent fix updated with a DR position will be adequate. But when conflicting information or information of questionable reliability is received, the navigator must determine the MPP.

When complete positional information is lacking, or when the available information is questionable, the most probable position might be determined from the intersection of a single line of position and a DR, from a line of soundings, from lines of position which are somewhat inconsistent, or from a dead reckoning position with a correction for set and drift. Continue a dead reckoning plot from one fix to another because the DR plot often provides the best estimate of the MPP.

A series of estimated positions may not be consistent because of the continual revision of the estimate as additional information is received. However, it is good practice to plot all MPP's, and sometimes to maintain a separate EP plot based upon the best estimate of track and speed made good. This could indicate whether the present course is a safe one.

2803. Plotting Sheets

If plotting sheets are not available, a Mercator plotting sheet can be constructed through either of two alternative methods based upon a graphical solution of the secant of the latitude, which approximates the expansion of latitude.

First method (Figure 2803a):

Step one: Draw a series of equally spaced vertical lines at any spacing desired. These are the meridians; label them at any desired interval, such as 1', 2', 5', 10', 30', 1°, etc.

Step two: Draw and label a horizontal line through the center of the sheet to represent the parallel of the mid-latitude of the area.

Step three: Through any convenient point, such as the intersection of the central meridian and the parallel of the mid-latitude, draw a line making an angle with the horizontal equal to the mid-latitude. In Figure 2803a this angle is 35°.

Step four: Draw in and label additional parallels. The length of the oblique line between meridians is the perpendicular distance between parallels, as shown by the broken arc. The number of minutes of arc between parallels is the same as that between the meridians.

Step five: Graduate the oblique line into convenient units. If 1' is selected, this scale serves as both a latitude and mile scale. It can also be used as a longitude scale by measuring horizontally from a meridian instead of obliquely along the line.

The meridians may be shown at the desired interval and the mid-parallel may be printed and graduated in units of longitude. In using the sheet it is necessary only to label the meridians and draw the oblique line. From it you may determine the interval used to draw in and label additional parallels. If the central meridian is graduated, the oblique line need not be.

Second method (Figure 2803b):

Step one: At the center of the sheet draw a circle with a radius equal to 1° (or any other convenient unit) of latitude at the desired scale. If a sheet with a compass rose is available, as in Figure 2803b, the compass rose can be used as the circle and will prove useful for measuring directions. It need not limit the scale of

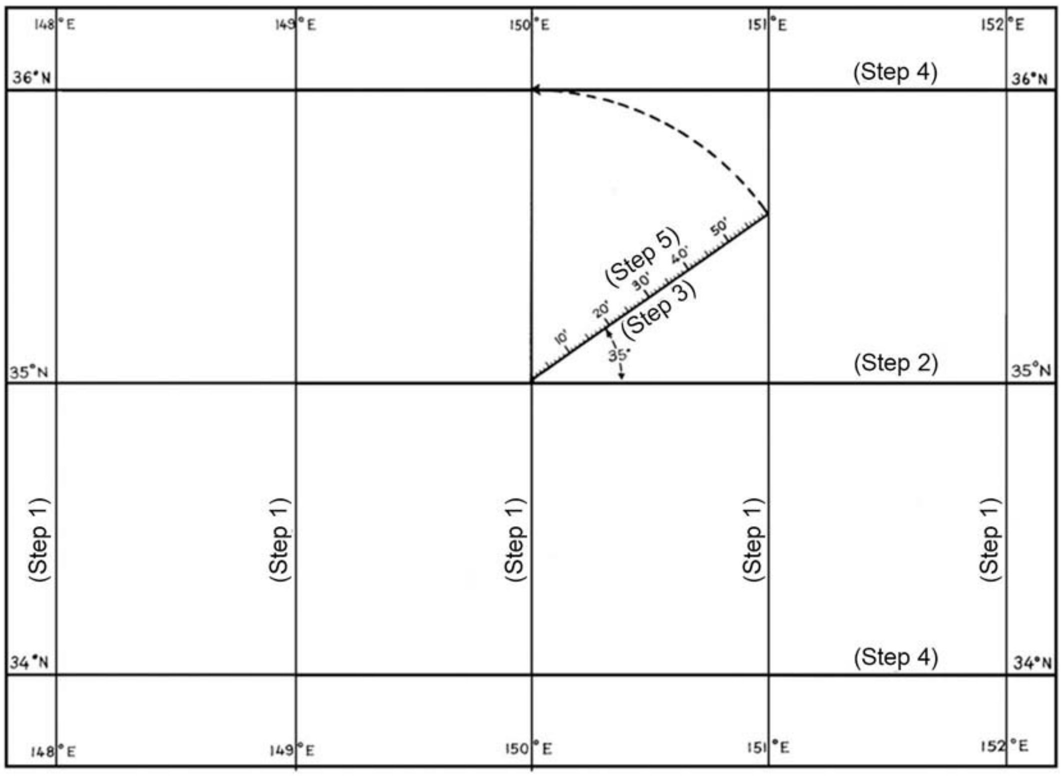

Figure 2803a. Small area plotting sheet with selected longitude scale.

the chart, as an additional concentric circle can be drawn, and desired graduations extended to it.

Step two: Draw horizontal lines through the center of the circle and tangent at the top and bottom. These are parallels of latitude; label them accordingly, at the selected interval (as every 1°, 30', etc.).

Step three: From the center of the circle draw a line making an angle with the horizontal equal to the mid-latitude. In Figure 2803b this angle is 40°.

Step four: Draw in and label the meridians. The first is a vertical line through the center of the circle. The second is a vertical line through the intersection of the oblique line and the circle. Additional meridians are drawn the same distance apart as the first two.

Step five: Graduate the oblique line into convenient units. If 1' is selected, this scale serves as a latitude and mile scale. It can also be used as a longitude scale by measuring horizontally from a meridian, instead of obliquely along the line.

In the second method, the parallels may be shown at the desired interval, and the central meridian may be printed and graduated in units of latitude. In using the sheet it is necessary only to label the parallels, draw the oblique line, and from it determine the interval and draw in and label additional meridians. If the central meridian is graduated, as shown in Figure 2803b, the oblique line need not be.

The same result is produced by either method. The first method, starting with the selection of the longitude scale, is particularly useful when the longitude limits of the plotting sheet determine the scale. When the latitude coverage is more important, the second method may be preferable. In either method a simple compass rose might be printed.

Both methods use a constant relationship of latitude to longitude over the entire sheet and both fail to allow for the ellipticity of the Earth. For practical navigation these are not important considerations.

2804. Dead Reckoning

Of the various types of navigation, dead reckoning alone is always available in some form. In an emergency it is of more than average importance. With electronic systems out of service, keep a close check on speed, direction, and distance made good. Carefully evaluate the effects of wind and current. Long voyages with accurate landfalls have been successfully completed by this method alone. This is not meant to minimize the importance of other methods of determining position. However, a good dead reckoning position may actually be more accurate than one determined from several inexact LOP's. If the means of deter-

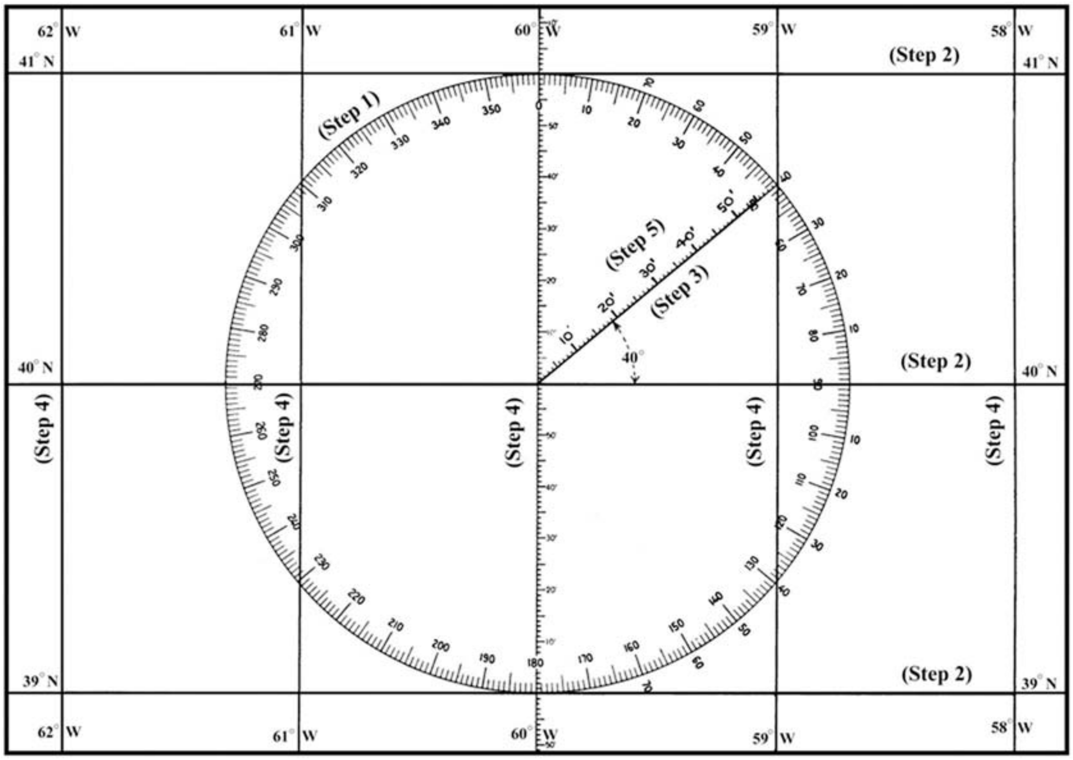

Figure 2803b. Small area plotting sheet with selected latitude scale.

Angle	0		18		31		41		49		56		63		69		75		81		87		90
Factor		1.0		0.9		0.8		0.7		0.6		0.5		0.4		0.3		0.2		0.1		0.0	

Table 2804. Simplified traverse table.

mining direction and distance (the elements of dead reckoning) are accurate, it may be best to adjust the dead reckoning only after a confident fix.

Plotting can be done directly on a *pilot chart* or plotting sheet. If this proves too difficult, or if an independent check is desired, some form of mathematical reckoning may be useful. Table 2804, a simplified traverse table, can be used for this purpose. To find the difference or change of latitude in minutes, enter the table with course angle, reckoned from north or south toward the east or west. Multiply the distance run in miles by the factor. To find the departure in miles, enter the table with the complement of the course angle. Multiply the distance run in miles by the factor. To convert departure to difference of longitude in minutes, enter the table with mid-latitude and divide the departure by the factor.

Example: *A vessel travels 26 miles on course 205°, from Lat. 41°44'N, Long. 56°21'W.*

Required: *Latitude and longitude of the point of arrival.*

Solution: *The course angle is 205° - 180° = S25°W, and the complement is 90° - 25° = 65°. The factors corresponding to these angles are 0.9 and 0.4, respectively. The difference of latitude is 26 0.9 = 23' (to the nearest minute) and the departure is 26 0.4 = 10 NM. Since the course is in the southwestern quadrant in the Northern Hemisphere, the latitude of the point of arrival is 41°44'N -23' = 41°21'N. The factor corresponding to the mid-latitude 41°32'N is 0.7. The difference of longitude is 10 0.7 = 14'. The longitude of the point of arrival is 56°21'W + 14 = 56°35'W.*

Answer: *Lat. 41°21'N, Long. 56°35'W.*

2805. Deck Log

At the onset of a navigational emergency, a navigation log should be started if a deck log is not already being maintained. The date and time of the casualty should be the first entry, followed by navigational information such as ship's position, status of all navigation systems, the decisions made, and the reasons for them.

The best determination of the position of the casualty should be recorded, followed by a full account of courses, distances, positions, winds, currents, and leeway. No important navigational information should be left to memory.

2806. Direction

Direction is one of the elements of dead reckoning. A deviation table for each compass, including any lifeboat compasses, should already have been determined. In the event of destruction or failure of the gyrocompass and bridge magnetic compass, lifeboat compasses can be used.

If an almanac, accurate Greenwich time, and the necessary tables are available, the azimuth of any celestial body can be computed and this value compared with an azimuth measured by the compass. If it is difficult to observe the compass azimuth, select a body dead ahead and note the compass heading. The difference between the computed and observed azimuths is compass error on that heading. This is of more immediate value than deviation, but if the latter is desired, it can be determined by applying variation to the compass error.

Several unique astronomical situations occur, permitting determination of azimuth without computation:

Polaris: Polaris is always within 2° of true north for observers between the equator and about 60° North. When Polaris is directly above or below the celestial pole, its azimuth is true north at any latitude. This occurs when the trailing star of either Cassiopeia or the Big Dipper is directly above or below Polaris. When these two stars form a horizontal line with Polaris, the maximum correction applies. Below about 50° latitude, this correction is 1°, and between 50° and 65°, it is 2°. If Cassiopeia is to the right of Polaris, the azimuth is 001° (002° above 50°N), and if Cassiopeia is to the left of Polaris, the azimuth is 359° (358° above 50°N).

The south celestial pole is located approximately at the intersection of a line through the longer axis of the Southern Cross with a line from the northernmost star of Triangulum Australe, perpendicular to the line joining the other two stars of the triangle. No conspicuous star marks this spot.

Meridian Transit: Any celestial body bears due north or south at meridian transit, either upper or lower. This is the moment of maximum (or minimum) altitude of the body. However, since the altitude at this time is nearly constant during a considerable change of azimuth, the instant of meridian transit may be difficult to determine. If time and an almanac are available, and the longitude is known, the time of transit can be computed. It can also be graphed as a curve on graph paper and the time of meridian transit determined with sufficient accuracy for emergency purposes.

Body on Prime Vertical: If any method is available for determining when a body is on the prime vertical (due east or west), the compass azimuth at this time can be observed. Table 21, Meridian Angle and Altitude of a Body on the Prime Vertical Circle, provides this information. Any body on the celestial equator (declination 0°) is on the prime vertical at the time of rising or setting. For the Sun this occurs at the time of the equinoxes. The star Mintaka (δ Orionis), the leading star of Orion's belt, has a declination of approximately 0.3°S and can be considered on the celestial equator. For an observer near the equator, such a body is always nearly east or west. Because of refraction and dip, the azimuth should be noted when the center of the Sun or a star is a little more than one Sun diameter (half a degree) above the horizon. The Moon should be observed when its upper limb is on the horizon.

Body at Rising or Setting: Except for the Moon, the azimuth angle of a body is almost the same at rising as at setting, except that the former is toward the east and the latter toward the west. If the azimuth is measured both at rising and setting, true south (or north) is midway between the two observed values, and the difference between this value and 180° (or 000°) is the compass error. Thus, if the compass azimuth of a body is 073° at rising, and 277° at setting, true south (180°) is $\frac{073° + 277°}{2} = 175°$ by compass, and the compass error is 5°E. This method may be in error if the vessel is moving rapidly in a northerly or southerly direction. If the declination and latitude are known, the true azimuth of any body at rising or setting can be determined by means of a diagram on the plane of the celestial meridian or by computation. For this purpose, the body (except the Moon) should be considered as rising or setting when its center is a little more than one Sun diameter (half a degree) above the horizon, because of refraction and dip.

Finding direction by the relationship of the Sun to the hands of a watch is sometimes advocated, but the limitations of this method prevent its practical use at sea.

A simple technique can be used for determining deviation. Find an object that is easily visible and that floats, but will not drift too fast in the wind. A life preserver, or several tied together, will suffice. Throw this marker overboard, and steer the vessel steadily in the exact opposite direction to the chosen course. At a distance of perhaps half a mile, or more if the marker is still clearly in view, execute a Williamson turn, or turn the vessel 180° in the smallest practical radius, and head back toward the marker. The magnetic course will be midway between the course toward the object and the reciprocal of the course away from the object. Thus, if the boat is on compass course 151° while heading away from the object, and 337° while returning, the magnetic course is midway between 337° and 151° + 180° = 331°, or

$$\frac{337° + 331°}{2} = 334° .$$

Since 334° magnetic is the same as 337° by compass, the deviation on this heading is 3°W.

If a compass is not available, any celestial body can be used to steer by, if its diurnal apparent motion is considered. A reasonably straight course can be steered by noting the direction of the wind, the movement of the clouds, the direction of the waves, or by watching the wake of the vessel. The angle between the centerline and the wake is an indication of the amount of leeway.

A body having a declination the same as the latitude of the destination is directly over the destination once each day, when its hour angle equals the longitude, measured westward through

360°. At this time it should be dead ahead if the vessel is following the great circle leading directly to the destination. Inspect the almanac to find a body with a suitable declination.

EMERGENCY CELESTIAL NAVIGATION

2807. Almanacs

Almanac information, particularly declination and Greenwich Hour Angle of bodies, is important to celestial navigation. If the only copy available is for a previous year, it can be used for the Sun, Aries (♈), and stars without serious error by emergency standards. However, for greater accuracy, proceed as follows:

For declination of the Sun, enter the almanac with a time that is earlier than the correct time by $5^h\ 49^m$ multiplied by the number of years between the date of the almanac and the correct date, adding 24 hours for each February 29th that occurs between the dates. If the date is February 29th, use March 1 and reduce by one the number of 24 hour periods added. For GHA of the Sun or Aries, determine the value for the correct time, adjusting the minutes and tenths of arc to agree with that at the time for which the declination is determined. Since the adjustment never exceeds half a degree, care should be used when the value is near a whole degree, to prevent the value from being in error by 1°.

If no almanac is available, a rough approximation of the declination of the Sun can be obtained as follows: Count the days from the given date to the nearer solstice (June 21st or December 22nd). Divide this by the number of days from that solstice to the equinox (March 21st or September 23rd), using the equinox that will result in the given date being between it and the solstice. Multiply the result by 90°. Enter Table 2804 with the angle so found and extract the factor. Multiply this by 23.45° to find the declination.

Example 1: *The date is August 24th.*

Required: *The approximate declination of the Sun.*

Solution: *The number of days from the given date to the nearer solstice (June 21) is 64. There are 94 days between June 21 and September 23. Dividing and multiplying by 90°,*

$$\frac{64}{94} \quad 90^{\circ} = 61.3'$$

The factor from Table 2804 is 0.5. The declination is 23.45°   0.5 = 11.7°. We know it is north because of the date.

Answer: *Dec. 11.7°N.*

The accuracy of this solution can be improved by considering the factor of Table 2804 as the value for the mid-angle between the two limiting ones (except that 1.00 is correct for 0° and 0.00 is correct for 90°), and interpolating to one additional decimal. In this instance the interpolation would be between 0.50 at 59.5° and 0.40 at 66°. The interpolated value is 0.47, giving a declination of 11.0°N. Still greater accuracy can be obtained by using a table of natural cosines instead of Table 2804. By natural cosine, the value is 11.3°N.

If the latitude is known, the declination of any body can be determined by observing a meridian altitude. It is usually best to make a number of observations shortly before and after transit, plot the values on graph paper, letting the ordinate (vertical scale) represent altitude, and the abscissa (horizontal scale) the time. The altitude is found by fairing a curve or drawing an arc of a circle through the points, and taking the highest value. A meridian altitude problem is then solved in reverse.

Example 2: *The latitude of a vessel is 40°16'S. The Sun is observed on the meridian, bearing north. The observed altitude is 36°29'.*

Required: *Declination of the Sun.*

Solution: *The zenith distance is 90° - 36°29' = 53°31'. The Sun is 53°31' north of the observer, or 13°15' north of the equator. Hence, the declination is 13°15' N.*

Answer: *Dec. 13°15' N.*

The GHA of Aries can be determined approximately by considering it equal to GMT (in angular units) on September 23rd. To find GHA Aries on any other date, add 1° for each day following September 23rd. The value is approximately 90° on December 22nd, 180° on March 21st and 270° on June 21st. The values found can be in error by as much as several degrees, and so should not be used if better information is available. An approximate check is provided by the great circle through Polaris, Caph (the leading star of Cassiopeia), and the eastern side of the square of Pegasus. When this great circle coincides with the meridian, LHA ♈ is approximately 0°. The hour angle of a body is equal to its SHA plus the hour angle of Aries. If an error of up to 4°, or a little more, is acceptable, the GHA of the Sun can be considered equal to GMT ± 180° (12^h).

For more accurate results, one can make a table of the equation of time from the *Nautical Almanac* perhaps at five- or ten-day intervals, and include this in the emergency navigation kit. The equation of time is applied according to its sign to GMT ± 180° to find GHA.

2808. Altitude Measurement

With a sextant, altitudes are measured in the usual manner. If in a small boat or raft, it is a good idea to make a number of observations and average both the altitudes and times, or plot on graph paper the altitudes versus time. The rougher the sea, the more important this process becomes, which tends to average out errors caused by rough weather observations.

The improvisations which may be made in the absence of a sextant are so varied that in virtually any circumstances a little ingenuity will produce a device to measure altitude. The results obtained with any improvised method will be approximate at best, but if a number of observations are averaged, the accuracy can be improved. A measurement, however approximate, is better than an estimate. Two general types of improvisation are available:

1. Circle. Any circular degree scale, such as a maneuvering board, compass rose, protractor, or plotter can be used to measure altitude or zenith distance directly. This is the principle of the ancient astrolabe. A maneuvering board or compass rose can be mounted on a flat board. A protractor or plotter may be used directly. There are a number of variations of the technique of using such a device. Some of them are:

A peg or nail is placed at the center of the circle as seen in Figure 2808a. A weight is hung from the 90° graduation, and a string for holding the device is attached at the 270° graduation. When it is held with the weight acting as a plumb bob, the 0° - 180° line is horizontal. In this position the board is turned in azimuth until it is in line with the Sun. The intersection of the shadow of the center peg with the arc of the circle indicates the altitude of the center of the Sun.

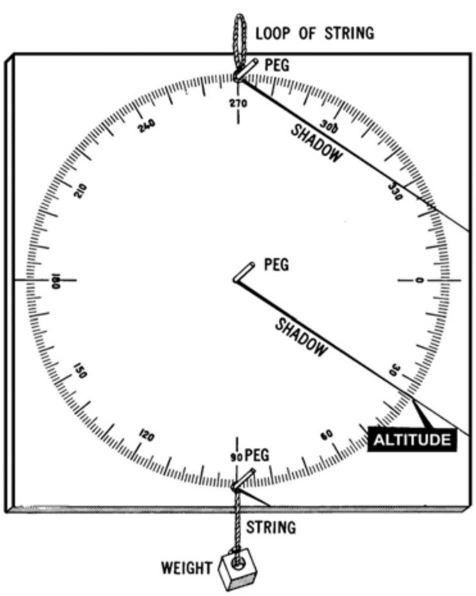

Figure 2808a. Improvised astrolabe; shadow method.

The weight and loop can be omitted and pegs placed at the 0° and 180° points of the circle. While one observer sights along the line of pegs to the horizon, an assistant notes the altitude.

The weight can be attached to the center pin, and the three pins (0°, center, 180°) aligned with the celestial body. The reading is made at the point where the string holding the weight crosses the scale. The reading thus obtained is the zenith distance unless the graduations are labeled to indicate altitude. This method, illustrated in Figure 2808b, is used for bodies other than the Sun.

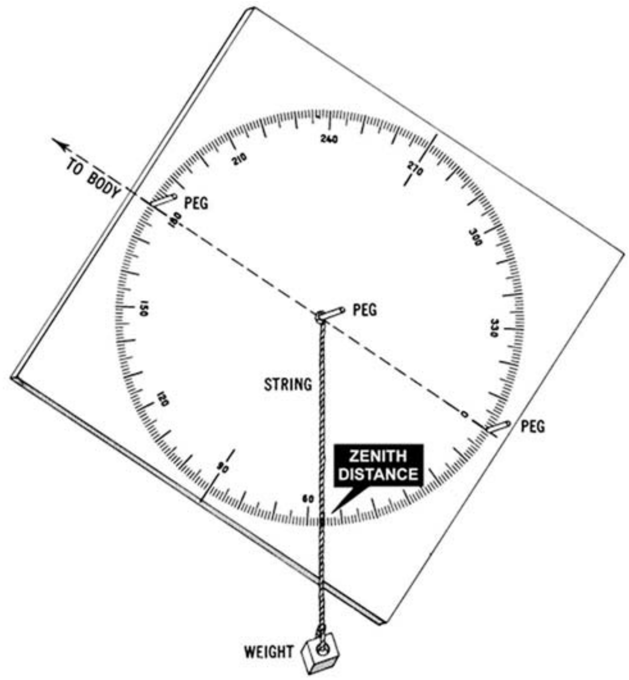

Figure 2808b. Improvised astrolabe; direct sighting method.

Whatever the technique, reverse the device for half the readings of a series to minimize errors of construction. Generally, the circle method produces more accurate results than the right triangle method, described below.

2. Right triangle. A cross-staff can be used to establish one or more right triangles, which can be solved by measuring the angle representing the altitude, either directly or by reconstructing the triangle. Another way of determining the altitude is to measure two sides of the triangle and divide one by the other to determine one of the trigonometric functions. This procedure, of course, requires a source of information on the values of trigonometric functions corresponding to various angles. If the cosine is found, Table 2804 can be used. The tabulated factors can be considered correct to one additional decimal for the value midway between the limited values (except that 1.00 is the correct value for 0° and 0.00 is the correct value for 90°) without serious error by emergency standards. Interpolation can then be made between such values.

By either protractor or table, most devices can be graduated in advance so that angles can be read directly. There are many variations of the right triangle method. Some of these are described below.

Two straight pieces of wood can be attached to each other in such a way that the shorter one can be moved along the longer, the two always being perpendicular to each other. The shorter piece is attached at its center. One end of the longer arm is held to the eye. The shorter arm is moved until its top edge is in line with the celestial body, and its bottom edge is in line with the horizon. Thus, two right triangles are formed, each representing half the altitude. See Figure 2808c.For low altitudes, only one of the triangles is used, the long arm being held in line with the horizon. The length of half the short arm, divided by the length of that part of the long arm between the eye and the intersection with the short arm, is the tangent of half the altitude (the whole altitude if only one right triangle is used). The cosine can be found by dividing that part of the long arm between the eye and the intersection with the short arm by the slant distance from the eye to one end of the short arm. Graduations consist of a series of marks along the long arm indicating settings for various angles. The device should be inverted for alternate readings of a series.

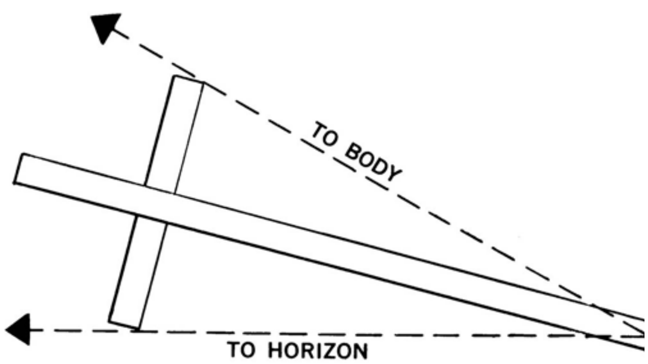

Figure 2808c. Improvised cross-staff.

A rule or any stick can be held at arm's length. The top of the rule is placed in line with the celestial body being observed, and the top of the thumb is placed in line with the horizon. The rule is held vertically. The length of rule above the thumb divided by the distance from the eye to the top of the thumb is the tangent of the angle observed. The cosine can be found by dividing the distance from the eye to the top of the thumb by the distance from the eye to the top of the rule. If the rule is tilted toward the eye until the minimum of rule is used, the distance from the eye to the middle of the rule is substituted for the distance from the eye to the top of the thumb, half the length of the rule above the thumb is used, and the angle found is multiplied by 2. Graduations consist of marks on the rule or stick indicating various altitudes. For the average observer each inch of rule will subtend an angle of about 2.3°, assuming an eye-to-ruler distance of 25 inches. This relationship is good to a maximum altitude of about 20°.

The accuracy of this relationship can be checked by comparing the measurement against known angles in the sky. Angular distances between stars can be computed by sight reduction methods, including *Pub. No. 229*, by using the declination of one star as the latitude of the assumed position, and the difference between the hour angles (or SHAs) of the two bodies as the local hour angle. The angular distance is the complement of the computed altitude. The angular distances between some well-known star pairs are: end stars of Orion's belt, 2.7°; pointers of the Big Dipper, 5.4°, Rigel to Orion's belt, 9.0°; eastern side of the great square of Pegasus, 14.0°; Dubhe (the pointer nearer Polaris) and Mizar (the second star in the Big Dipper, counting from the end of the handle), 19.3°.

The angle between the lines of sight from each eye is, at arm's length, about 6°. By holding a pencil or finger horizontally and placing the head on its side, one can estimate an angle of about 6° by closing first one eye and then the other, and noting how much the pencil or finger appears to move in the sky.

The length of the shadow of a peg or nail mounted perpendicular to a horizontal board can be used as one side of an altitude triangle. The other sides are the height of the peg and the slant distance from the top of the peg to the end of the shadow. The height of the peg divided by the length of the shadow is the tangent of the altitude of the center of the Sun. The length of the shadow divided by the slant distance is the cosine. Graduations consist of a series of concentric circles indicating various altitudes, the peg being at the common center. The device is kept horizontal by floating it in a bucket of water. Half the readings of a series are taken with the board turned 180° in azimuth.

Two pegs or nails can be mounted perpendicular to a board, with a weight hung from the one farther from the eye. The board is held vertically and the two pegs aligned with the body being observed. A finger is then placed over the string holding the weight, to keep it in position as the board is turned on its side. A perpendicular line is dropped from the peg nearer the eye to the string. The body's altitude is the acute angle nearer the eye. For alternate readings of a series, the board should be inverted. Graduations consist of a series of marks indicating the position of the string at various altitudes.

As the altitude decreases the triangle becomes smaller. At the celestial horizon it becomes a straight line. No instrument is needed to measure the altitude when either the upper or lower limb is tangent to the horizon, as the sextant altitude is then 0°.

2809. Sextant Altitude Corrections

If altitudes are measured by a marine sextant, the usual sextant altitude corrections apply. If the center of the Sun or Moon is observed, either by sighting at the center or by shadow, the lower-limb corrections should be applied as usual, and an additional correction of minus 16' applied. If the upper limb is observed, use minus 32'. If a weight is used as a plumb bob, or if the length of a shadow is measured, omit the dip (height of eye) correction.

If an almanac is not available for corrections, each source of error can be corrected separately, as follows:

If a sextant is used, the **index correction** should be determined and applied to all observations, or the sextant adjusted to eliminate index error.

Refraction is given to the nearest minute of arc in Table

Altitude	5°		6°		7°		8°		10°		12°		15°		21°		33°		63°		90°
Refraction		9'		8'		7'		6'		5'		4'		3'		2'		1'		0	

Table 2809. Simplified refraction table.

2809. The value for a horizon observation is 34'. If the nearest 0.1° is sufficiently accurate, as with an improvised method of observing altitude, a correction of 0.1° should be applied for altitudes between 5° and 18°, and no correction applied for greater altitudes. Refraction applies to all observations, and is always minus.

Dip, in minutes of arc, is approximately equal to the square root of the height of eye, in feet. The dip correction applies to all observations in which the horizon is used as the horizontal reference. It is always a minus. If 0.1° accuracy is acceptable, no dip correction is needed for height of eye in a small boat.

The **semidiameter** of the Sun and Moon is approximately 16' of arc. The correction does not apply to other bodies or to observations of the center of the Sun and Moon, by whatever method, including shadow. The correction is positive if the lower limb is observed, and negative if the upper limb is observed.

For emergency accuracy, **parallax** is applied to observations of the Moon only. An approximate value, in minutes of arc, can be found by multiplying 57' by the factor from Table 2804, entering that table with altitude. For more accurate results, the factors can be considered correct to one additional decimal for the altitude midway between the limiting values (except that 1.00 is correct for 0° and 0.00 is correct for 90°), and the values for other altitudes can be found by interpolation. This correction is always positive.

For observations of celestial bodies on the horizon, the total correction for zero height of eye is:

Sun:	Lower limb: (–)18', upper limb: (–)50'.
Moon:	Lower limb: (+)39', upper limb: (+)7'.

Planet/Star: (-)34°.

Dip should be added algebraically to these values. Since the sextant altitude is zero, the observed altitude is equal to the total correction.

2810. Sight Reduction

Sight reduction tables should be used, if available. If not, use the compact *sight reduction tables* found in the *Nautical Almanac*. If trigonometric tables and the necessary formulas are available, they will serve the purpose. Speed in solution is seldom a factor in a liferaft, but might be important aboard ship, particularly in hostile areas. If tables but no formulas are available, determine the mathematical knowledge possessed by the crew. Someone may be able to provide the missing information. If the formulas are available, but no tables, approximate natural values of the various trigonometric functions can be obtained graphically. Graphical solution of the navigational triangle can be made by the orthographic method explained in Chapter 13, Navigational Astronomy. A maneuvering board might prove helpful in the graphical solution for either trigonometric functions or altitude and azimuth. Very careful work will be needed for useful results by either method. Unless proper navigational equipment is available, better results might be obtained by making separate determinations of latitude and longitude.

2811. Finding Latitude

Several methods are available for determining latitude; none requires accurate time.

Latitude can be determined using a **meridian altitude** of any body, if its declination is known. If accurate time, knowledge of the longitude, and an almanac are available, the observation can be made at the correct moment, as determined in advance. However, if any of these are lacking, or if an accurate altitude measuring instrument is unavailable, it is better to make a number of altitude observations before and after meridian transit. Then plot altitude versus time on graph paper, and the highest (or lowest, for lower transit) altitude is scaled from a curve faired through the plotted points. At small boat speeds, this procedure is not likely to introduce a significant error. The time used for plotting the observations need not be accurate, as elapsed time between observations is all that is needed, and this is not of critical accuracy. Any altitudes that are not consistent with others of the series should be discarded.

Latitude by Polaris is explained in Chapter 19, Sight Reduction. In an emergency, only the first correction is of practical significance. If suitable tables are not available, this correction can be estimated. The trailing star of Cassiopeia (ε Cassiopeiae) and Polaris have almost exactly the same SHA. The trailing star of the Big Dipper (Alkaid) is nearly opposite Polaris and ε Cassiopeiae. These three stars, ε Cassiopeiae, Polaris, and Alkaid, form a line through the N. Celestial Pole (approximately). When this line is horizontal, there is no correction. When it is vertical, the maximum correction of 56' applies. It should be added to the observed altitude if Alkaid is at the top, and subtracted if ε Cassiopeiae is at the top. For any other position, estimate the angle this line makes with the vertical, and multiply the maximum correction (56') by the factor from Table 2804, adding if Alkaid is higher than ε Cassiopeiae, and subtracting if it is lower. See Figure 2811. For more accurate results, the factor from Table 2804 can be considered accurate to one additional decimal for the mid-value between those tabulated (except that 1.00 is correct for 0° and 0.00 for 90°). Other values can be found by interpolation.

The **length of the day** varies with latitude. Hence, latitude can be determined if the elapsed time between sunrise and sunset can be accurately observed. Correct the

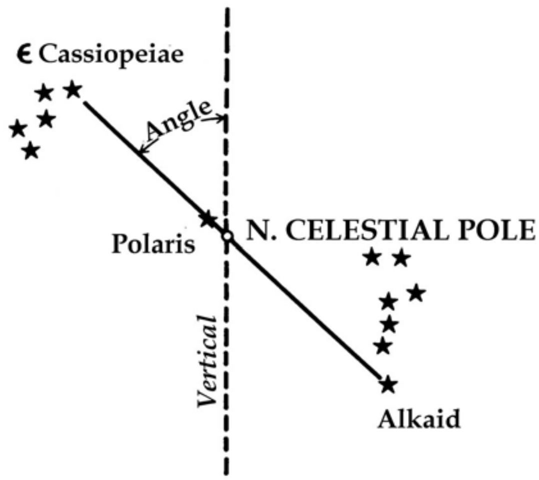

Figure 2811. Relative positions of ε Cassiopeiae, Polaris, and Alkaid with respect to the north celestial pole.

observed length of day by adding 1 minute for each 15' of longitude traveled toward the east and subtracting 1 minute for each 15' of longitude traveled toward the west. The latitude determined by length of day is the value for the time of meridian transit. Since meridian transit occurs approximately midway between sunrise and sunset, half the interval may be observed and doubled. If a sunrise and sunset table is not available, the length of daylight can be determined graphically using a diagram on the plane of the celestial meridian, as explained in Chapter 13. A maneuvering board is useful for this purpose. This method cannot be used near the time of the equinoxes and is of little value near the equator. The Moon can be used if moonrise and moonset tables are available. However, with the Moon, the half-interval method is of insufficient accuracy, and allowance should be made for the longitude correction.

The declination of a **body in zenith** is equal to the latitude of the observer. If no means are available to measure altitude, the position of the zenith can be determined by holding a weighted string overhead.

2812. Finding Longitude

Unlike latitude, determining longitude requires accurate Greenwich time. All such methods consist of noting the Greenwich time at which a phenomenon occurs locally. In addition, a table indicating the time of occurrence of the same phenomenon at Greenwich, or equivalent information, is needed. Three methods may be used to determine longitude.

When a body is on the local celestial meridian, its GHA is the same as the longitude of the observer if in west longitude, or 360 - λ in east longitude. Thus, if the GMT of local **time of transit** is determined and a table of Greenwich Hour Angles (or time of transit of the Greenwich meridian) is available, longitude can be computed. If only the equation of time is available, the method can be used with the Sun. This is the reverse of the problem of finding the time of transit of a body. The time of transit is not always apparent. If a curve is made of altitude versus time, as suggested previously, the time corresponding to the highest altitude is used in finding longitude. Under some conditions, it may be preferable to observe an altitude before meridian transit, and then again after meridian transit when the body has returned to the same altitude as at the first observation. Meridian transit occurs midway between these two times. A body in the zenith is on the celestial meridian. If accurate azimuth measurement is available, note the time when the azimuth is 000° or 180°.

The difference between the observed GMT of sunrise or sunset and the LMT tabulated in the almanac is the longitude in time units, which can then be converted to angular measure. If the *Nautical Almanac* is used, this information is tabulated for each third day only. Greater accuracy can be obtained if interpolation is used for determining intermediate values. Moonrise or moonset can be used if the tabulated LMT is corrected for longitude. Planets and stars can be used if the time of rising or setting can be determined. This can be computed, or approximated using a diagram on the plane of the celestial meridian (See Chapter 13, Navigational Astronomy).

Either of these methods can be used in reverse to set a watch that has run down or to check the accuracy of a watch if the longitude is known. In the case of a meridian transit, the time at the instant of transit is not necessary.

Simply start the watch and measure the altitude several times before and after transit, or at equal altitudes before and after transit. Note the times of these observations and find the exact watch time of meridian transit. The difference between this time and the correct time of transit is the correction factor by which to reset the watch.

CHAPTER 29

NAVIGATION REGULATIONS

SHIP ROUTING

2900. Purpose and Types of Routing Systems

Navigation, once independent throughout the world, is an increasingly regulated activity. The consequences of collision or grounding for a large, modern ship carrying tremendous quantities of high-value, perhaps dangerous cargo are so severe that authorities have instituted many types of regulations and control systems to minimize the chances of loss. These range from informal and voluntary systems to closely controlled systems requiring strict compliance with numerous regulations. The regulations may concern navigation, communications, equipment, procedures, personnel, and many other aspects of ship management. This chapter will be concerned primarily with navigation regulations and procedures.

There are many types of vessel traffic rules. However, the cornerstone of all these are the *Navigation Rules: International-Inland*. The International Rules (Title 33 U.S.C. Chap. 30) were formalized in the Convention of the International Regulations for the Preventing of Collisions at Sea of 1972 (COLREGS '72) and became effective on July 15, 1977. Following the signing of the Convention, an effort was made to unify and update the various domestic navigation rules. This effort culminated in the enactment of the Inland Navigation Rules Act of 1980.

The Inland Navigation Rules (Title 33 U.S.C. Chap. 34) recodified parts of the Motorboat Act of 1940 and a large body of existing navigational practices, pilot rules, interpretive rules previously referred to as the Great Lakes Rules, Inland Rules and Western River Rules. The effective date for the Inland Navigation Rules was December 24, 1981, except for the Great Lakes where the effective date was March 1, 1983.

The International Rules apply to vessels on waters outside of the established lines of demarcation (COLREGS Demarcation Lines, 33 C.F.R. §80). These lines are depicted on U.S. charts with dashed lines, and generally run between major headlands and prominent points of land at the entrance to coastal rivers and harbors. The Inland Navigation Rules apply to waters inside the lines of demarcation. It is important to note that with the exception of Annex V to the Inland Rules, the International and Inland Navigation Rules are very similar in both content and format.

Much information relating to maritime regulations may be found on the World Wide Web, and any common search engine can turn up increasing amounts of documents posted for mariners to access. As more and more regulatory information is posted to new Web sites and bandwidth increases, mariners will have easier access to the numerous rules with which they must comply.

2901. Terminology

There are several specific types of regulatory systems. For commonly used open ocean routes where risk of collision is present, the use of **Recommended Routes** separates ships going in opposite directions. In areas where ships converge at headlands, straits, and major harbors, **Traffic Separation Schemes** (TSS's) have been instituted to separate vessels and control crossing and meeting situations. **Vessel Traffic Services** (VTS's), sometimes used in conjunction with a TSS, are found in many of the major ports of the world. While TSS's are often found offshore in international waters, VTS's are invariably found closer to shore, in national waters. Environmentally sensitive areas may be protected by **Areas to be Avoided** which prevent vessels of a certain size or carrying certain cargoes from navigating within specified boundaries. In confined waterways such as canals, lock systems, and rivers leading to major ports, local navigation regulations often control ship movement.

The following terms relate to ship's routing:

Routing System: Any system of routes or routing measures designed to minimize the possibility of collisions between ships, including TSS's, two-way routes, recommended tracks, areas to be avoided, inshore traffic zones, precautionary areas, and deep-water routes.

Traffic Separation Scheme: A routing measure which separates opposing traffic flow with traffic lanes.

Separation Zone or Line: An area or line which separates opposing traffic, separates traffic from adjacent areas, or separates different classes of ships from one another.

Traffic Lane: An area within which one-way traffic is established.

Roundabout: A circular traffic lane used at junctions of several routes, within which traffic moves counterclockwise around a separation point or zone.

Inshore Traffic Zone: The area between a traffic separation scheme and the adjacent coast, usually designated for coastal traffic.

Two-Way Route: A two-way track for guidance of ships through hazardous areas.

Recommended Route: A route established for convenience of ship navigation, often marked with centerline buoys.

Recommended Track: A route, generally found to be free of dangers, which ships are advised to follow to avoid possible hazards nearby.

Deep-Water Route: A route surveyed and chosen for the passage of deep-draft vessels through shoal areas.

Precautionary Area: A routing measure comprising an area within defined limits where vessels must navigate with particular caution and within which the direction of traffic may be recommended.

Area to be Avoided: An area within which navigation by certain classes of ships is prohibited because of particular navigational dangers or environmentally sensitive natural features. They are depicted on charts by dashed or composite lines. The smallest may cover less than a mile in extent; the largest may cover hundreds of square miles. Notes on the appropriate charts and in pilots and *Sailing Directions* tell which classes of ships are excluded from the area.

No Anchoring Area: A routing measure comprising an area within defined limits where anchoring is hazardous or could result in unacceptable damage to the marine environment. Anchoring in a no anchoring area should be avoided by all ships or certain classes of ships, except in case of immediate danger to the ship or the persons onboard.

Established Direction of Traffic Flow: The direction in which traffic within a lane must travel.

Recommended Direction of Traffic Flow: The direction in which traffic is recommended to travel.

There are various methods by which ships may be separated using Traffic Separation Schemes. The simplest scheme might consist of just one method. More complex schemes will use several different methods together in a coordinated pattern to route ships to and from several areas at once. Schemes may be just a few miles in extent, or cover relatively large sea areas.

2902. Recommended Routes and Tracks

Recommended Routes across the North Atlantic have been followed since 1898, when the risk of collision between increasing numbers of ships became too great, particularly at junction points. The International Convention for the Safety of Life at Sea (SOLAS) codifies the use of certain routes. These routes vary with the seasons, with winter and summer tracks chosen so as to avoid iceberg-prone areas. These routes are often shown on charts, particularly small scale ones, and are generally used to calculate distances between ports in tables.

Recommended Routes consist of single tracks, either one-way or two-way. Two-way routes show the best water through confined areas such as among islands and reefs. Ships following these routes can expect to meet other vessels head-on and engage in normal passings. One-way routes are generally found in areas where many ships are on similar or opposing courses. They are intended to separate opposing traffic so that most maneuvers are overtaking situations instead of the more dangerous meeting situation.

2903. Charting Routing Systems

Routing Systems and TSS's are depicted on nautical charts in magenta (purple) or black as the primary color. Zones are shown by purple tint, limits are shown by composite lines such as are used in other maritime limits, and lines are dashed. Arrows are outlined or dashed-lined depending on use. Deep-water routes are marked with the designation "DW" in bold purple letters, and the least depth may be indicated.

Recommended Routes and recommended tracks are generally indicated on charts by black lines, with arrowheads indicating the desired direction of traffic. Areas to be Avoided are depicted on charts by dashed lines or composite lines, either point to point straight lines or as a circle centered on a feature in question such as a rock or island.

Note that not all ship's routing measures are charted. U.S. charts generally depict recommended routes only on charts made directly from foreign charts. Special provisions applying to a scheme may be mentioned in notes on the chart and are usually discussed in detail in the *Sailing Directions*. In the U.S., the boundaries and routing scheme's general location and purpose are set forth in the Code of Federal Regulations and appear in the *Coast Pilot*.

TRAFFIC SEPARATION SCHEMES

2904. Traffic Separation Schemes (TSS)

In 1961, representatives from England, France, and Germany met to discuss ways to separate traffic in the congested Straits of Dover and subsequently in other congested areas. Their proposals were submitted to the

International Maritime Organization (IMO) and were adopted in general form. IMO expanded on the proposals and has since instituted a system of **Traffic Separation Schemes (TSS)** throughout the world. See Figure 2904 for a depiction of how a TSS may appear on a paper chart.

The IMO is the only international body responsible for establishing and recommending measures for ship's routing in international waters. It does not attempt to regulate traffic within the territorial waters of any nation.

In deciding whether or not to adopt a TSS, IMO considers the aids to navigation system in the area, the state of hydrographic surveys, the scheme's adherence to accepted standards of routing, and the International Rules of the Road. The selection and development of TSS's are the responsibility of individual governments, who may seek IMO adoption of their plans, especially if the system extends into international waters.

Governments may develop and implement TSS's not adopted by the IMO, but in general only IMO-adopted schemes are charted. Rule 10 of the International Regulations for Preventing Collisions at Sea (Rules of the Road) addresses the subject of TSS's. This rule specifies the actions to be taken by various classes of vessels in and near traffic separation schemes.

Traffic separation schemes adopted by the IMO are listed in *Ship's Routeing*, a publication of the IMO. Because of differences in datums, chartlets in this publication which depict the various schemes must not be used either for navigation or to chart the schemes on navigational charts. The *Notice to Mariners* should be consulted for charting details. The symbology for TSS tracks and routes are described in more detail in section "M" of *U.S. Chart No. 1*, (12th edition, 2013).

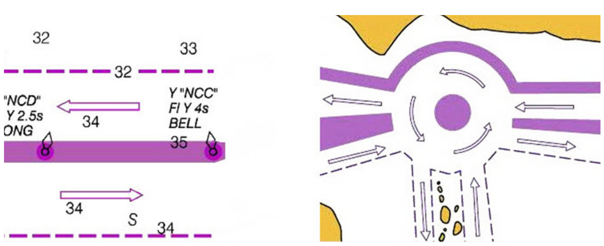

Figure 2904. Traffic separation scheme examples.

2905. Methods and Depiction

A number of different methods of separating traffic have been developed, using various zones, lines, and defined areas. One or more methods may be employed in a given traffic scheme to direct and control converging or passing traffic. These are discussed below. Refer to definitions in section 2901 and Figure 2905.

Method 1. Separation of opposing streams of traffic by separation zones or lines. In this method, typically a central separation zone is established within which ships are not to navigate. The central zone is bordered by traffic lanes with established directions of traffic flow. The lanes are bounded on the outside by limiting lines.

Method 2. Separation of opposing streams of traffic by natural features or defined objects. In this method islands, rocks, or other features may be used to separate traffic. The feature itself becomes the separation zone.

Method 3. Separation of through traffic from local traffic by provision of Inshore Traffic Zones. Inshore traffic zones provide an area within which local traffic may travel at will without interference from through traffic in the lanes. Inshore zones are separated from traffic lanes by separation zones or lines.

Method 4. Division of traffic from several different directions into sectors. This approach is used at points of convergence such as pilot stations and major entrances.

Method 5. Routing traffic through junctions of two or more major shipping routes. The exact design of the scheme in this method varies with conditions. It may be a circular or rectangular precautionary area, a roundabout, or a junction of two routes with crossing routes and directions of flow well defined.

2906. Use of Traffic Separation Schemes

A TSS is not officially approved for use until adopted by the IMO. Once adopted, it is implemented at a certain time and date and announced in the *Notice to Mariners* and by other means. The *Notice to Mariners* will also describe the scheme's general location and purpose, and give specific directions in the chart correction section on plotting the various zones and lines which define it. These corrections usually apply to several charts. Because the charts may range in scale from quite small to very large, the corrections for each should be followed closely. The positions for the various features may be slightly different from chart to chart due to differences in rounding off positions or chart datum.

Use of TSS's by all ships is recommended but not always required. In the event of a collision, vessel compliance with the TSS is a factor in assigning liability in admiralty courts. TSS's are intended for use in all weather, both day and night. Adequate aids to navigation are a part of all TSS's. There is no special right of one ship over another in TSS's because the *Rules of the Road* apply in all cases. Deep-water routes should be avoided by ships that do not need them to keep them clear for deep-draft vessels. Ships need not keep strictly to the courses indicated by the arrows, but are free to navigate as necessary within their lanes to avoid other traffic. The signal "YG" is provided in the International Code of Signals to indicate to another ship: "You appear not to be complying with the traffic separation scheme." TSS's are discussed in detail in the *Sailing Directions* for the areas where they are found.

No.	INT	Description	NOAA	NGA	Other NGA	ECDIS	
Routing Measures						Supplementary national symbols: d–e	
Basic Symbols							
10		Established (mandatory) direction of traffic flow					Traffic direction in a one-way lane of a traffic separation scheme
11		Recommended direction of traffic flow					Single traffic direction in a two-way route part of a traffic-separation scheme
12		Separation line (large scale, small scale)					Traffic separation line
13		Separation zone					Traffic separation zone
14		Limit of restricted routing measure (e.g. Inshore Traffic Zone (ITZ), Area to be Avoided (ATBA))	RESTRICTED AREA				
15		Limit of routing measure					Traffic separation scheme boundary
16		Precautionary area					Traffic precautionary area as a point
	Precautionary Area						Traffic precautionary area as an area
17	ASL (see Note)	Archipelagic Sea Lane (ASL); axis line and limit beyond which vessels shall not navigate					Axis and boundary of archipelagic sea lane
18	FAIRWAY 7.3m	Fairway designated by regulatory authority with minimum depth	SAFETY FAIRWAY 166.200 (see note A)				Fairway, depth is obtained by cursor pick
	FAIRWAY <7.3m>	Fairway designated by regulatory authority with maximum authorized draft					

Figure 2905. Extract from U.S. Chart No. 1. Routing measures symbology.

Certain special rules adopted by IMO apply in constricted areas such as the Straits of Malacca and Singapore, the English Channel and Dover Strait, and in the Gulf of Suez. These regulations are summarized in the appropriate *Sailing Directions (Planning Guides)*. For a complete summary of worldwide ships' routing measures, the IMO publication Ship's Routing should be obtained. See Section 2904.

VESSEL TRAFFIC SERVICES (VTS)

2907. Description and Purpose

Vessel Traffic Services in the U.S. are implemented under the authority of the Ports and Waterways Safety Act of 1972 (Public Law 92-340 as amended) and the St. Lawrence Seaway Act (Public Law 358).

The purpose of a **Vessel Traffic Service (VTS)** is to provide active monitoring and navigational advice for vessels in particularly confined and busy waterways. There are two main types of VTS, surveilled and non-surveilled. Surveilled systems consist of one or more land-based sensors (i.e. radar, AIS and closed circuit television sites), which output their signals to a central location where operators monitor and manage vessel traffic movement. Non-surveilled systems consist of one or more reporting points at which ships are required to report their identity, course, speed, and other data to the monitoring authority. They encompass a wide range of techniques and capabilities aimed at preventing vessel collisions and groundings in the harbor, harbor approach and inland waterway phase of navigation. They are also designed to expedite ship movements, increase transportation system efficiency, and improve all-weather operating capability

A VTS is a service implemented by a Competent Authority, designed to improve safety and efficiency of vessel traffic and to protect the environment. VTS's are equipped, staffed and enabled to interact with marine traffic through the provision of specific services and to respond to developing situations in the interest of safety and efficiency. In those ports where a VTS has been determined to be the appropriate traffic management tool, three levels of service have been defined to assist Competent Authorities in determining the type of service provided. The services and functions provided include:

Information Service (INS), this service normally provides the position, intentions and destination of vessels operating within the VTS area, usually by broadcasting information at fixed times and intervals or when deemed necessary by the VTS.

Traffic Organization Service (TOS), this service provides advance planning of movements and is particularly useful during times of congestion or waterways restriction. The VTS monitors traffic and enforces adherence to rules and regulations. The service may also include prioritization of movements, allocation of space, mandatory position reporting, established routes, speed limits, and/or other measures that may be considered necessary and appropriate by the VTS.

Navigation Assistance Service (NAS), this service may be provided in addition to an Information Service and/or Traffic Organization Service. The NAS is designed to assist in the on-board navigational decision-making process and is provided at the request of a vessel, or when deemed necessary by the VTS. The NAS provides essential and timely navigational information and may inform, advise and/or instruct vessels accordingly. Most major maritime nations now operate vessel traffic services in large, congested ports and harbors.

VHF-FM communications network forms the basis of most major services. Transiting vessels make position reports to a vessel traffic center by radiotelephone and are in turn provided with accurate, complete, and timely navigational safety information. The addition of a network of radars, AIS, and close circuit television cameras for surveillance and computer-assisted tracking, similar to that used in air traffic control, allows the VTS to play a more significant role in marine traffic management, thereby decreasing vessel congestion, critical encounter situations, and the probability of a marine casualty resulting in environmental damage.

Automatic Identification Systems (AIS) may be integrated into VTS operations. This rapidly developing technology is similar to the transponder in an aircraft, which sends out a radio signal containing information such as the name of the vessel, course, speed, etc. This data appears as a text tag, attached to the radar blip, on systems designed to receive and process the signals. It enhances the ability of VTS operators to monitor and control shipping in busy ports.

AIS technology relies upon global navigational positioning systems (GPS), navigation sensors, and digital communication equipment operating according to standardized protocols (AIS transponders) that permit the voiceless exchange of navigation information between vessels and shore-side vessel traffic centers. AIS transponders can broadcast vessel information such as name or call sign, dimensions, type, GPS position, course, speed, and navigation status. This information is continually updated and received by all AIS-equipped vessels in its vicinity. An AIS-based VTS reduces the need for voice interactions, enhances mariners' ability to navigate, improves their situational awareness, and assists them in the performance of their duties thus reducing the risk of collisions.

The Coast Guard recognized the importance of AIS and has led the way on various international fronts for acceptance and adoption of this technology. The Coast Guard permits certain variations of AIS in VTS Prince William Sound and has conducted or participated in extensive operational tests of several Universal AIS (ITU-R M.1371) precursors. The most comprehensive test bed has been on the Lower Mississippi River. AIS is discussed in greater detail in Chapter 30.

The **Nationwide Automatic Identification System (NAIS)** consists of approximately 200 VHF receiver sites located throughout the coastal continental United States, inland rivers, Alaska, Hawaii and Guam. NAIS is designed to collect AIS transmissions from local vessels. Currently, NAIS collects valuable maritime data in 58 critical ports throughout the United States for use by Coast Guard operators and port partners. The primary goal of NAIS is to increase Maritime Domain Awareness (MDA) through data dissemination via a network infrastructure, particularly focusing on improving maritime security, marine and navigational safety, search and rescue, and environmental protection services.

In response to the Maritime Transportation Security Act of 2002, the NAIS Project was initiated and officially chartered in December 2004. NAIS allows the USCG to collect safety and security data from AIS-equipped vessels in the nation's territorial waters and adjacent sea areas, and share that data with USCG operators and other government partners. AIS data collected improves the safety of vessels and ports through collision avoidance and the safety of the nation through detection, identification, and classification of vessels.

NAIS consists of an integrated system of AIS, data storage, processing, and networking infrastructure. In addition, NAIS integrates with other systems for purposes of sharing infrastructure, quicker implementation, and improved performance.

Ports and Waterways Safety System (PAWSS) is a major acquisition project to build new Vessel Traffic Services where necessary and replace existing systems. It is also a process that reaches out to port stakeholders to comprehensively assess safety and identify needed corrective actions.

The PAWSS Vessel Traffic Service (VTS) project is a national transportation system that collects, processes, and disseminates information on the marine operating environment and maritime vessel traffic in major U.S. ports and waterways. The PAWSS VTS mission is monitoring and assessing vessel movements within a Vessel Traffic Service Area, exchanging information regarding vessel movements with vessel and shore-based personnel, and providing advisories to vessel masters. Other Coast Guard missions are supported through the exchange of information with appropriate Coast Guard units.

The Coast Guard has a statutory responsibility under the Ports and Waterways Safety Act of 1972 (PWSA), Title 33 USC §1221 to ensure the safety and environmental protection of U.S. ports and waterways. The PWSA authorizes the Coast Guard to "...establish, operate and maintain vessel traffic services in ports and waterways subject to congestion." It also authorizes the Coast Guard to require the carriage of electronic devices necessary for participation in the VTS system. The purpose of the act was to establish good order and predictability on United States waterways by implementing fundamental waterways management practices. In 1996 the U.S. Congress required the Coast Guard to begin an analysis of future VTS system requirements. Congress specifically directed the Coast Guard to revisit the VTS program and focus on user involvement, meeting minimum safety needs, using affordable systems, using off-the-shelf technology, and exploring public-private partnership opportunities. The Coast Guard's PAWSS project was established to meet these goals.

The VTS system at each port has a Vessel Traffic Center that receives vessel movement data from the Automatic Identification System (AIS), surveillance sensors, other sources, or directly from vessels. Meteorological and hydrographic data is also received at the vessel traffic center and disseminate as needed. A major goal of the PAWSS VTS is to use AIS and other technologies that enable information gathering and dissemination in ways that add no additional operational burden to the mariner. The VTS adds value, improves safety and efficiency, but is not laborious to vessel operators.

Surveilled VTS's are found in many large ports and harbors where congestion is a safety and operational hazard. Less sophisticated services have been established in other areas in response to hazardous navigational conditions according to the needs and resources of the authorities.

Designated radio frequencies are port specific and denoted on the U.S. Coast Guard's Navigation Center webpage (www.navcen.uscg.gov). In the event of a communication failure either by the vessel traffic center or the vessel or radio congestion on a designated VTS frequency, communications may be established on an alternate VTS frequency. The bridge-to-bridge navigational frequency 156.650 MHz (Channel 13), is monitored in each VTS area; and it may be used as an alternate frequency, however, only to the extent that doing so provides a level of safety beyond that provided by other means.

2908. History of Vessel Traffic Services

The concept of managing ship movements through a shore-side radar station is generally accepted to have first appeared in the port of Liverpool in 1949. In 1956, the Netherlands established a system of radar stations for the surveillance of traffic at the port of Rotterdam. As VTS evolved and spread in Western Europe, the commercial well being of the port was the stimulus for new or expanded service. This contrasts sharply with the U.S. experience, where the first Federal (Coast Guard) VTS was an outgrowth of a 1968 research and development effort in San Francisco Bay called Harbor Advisory Radar. It was, as the name suggests, an advisory activity and participation in the system was voluntary. Because it was voluntary, not all vessels availed themselves of VTS assistance or contributed to the service.

On January 18, 1971, the tankers Arizona Standard and Oregon Standard collided under the Golden Gate Bridge. The incident received nationwide attention and resulted in two significant maritime related safety initiatives - The Bridge to Bridge Radiotelephone Act, Title 33 USC §1201 and The Ports and Waterways Safety Act of 1972 (PWSA), Title 33 USC §1221. It is from the latter that the Coast Guard draws its authority to construct, maintain and operate VTSs. It also authorizes the Coast Guard to require the carriage of electronic devices necessary for participation in the VTS system. The purpose of the act was to establish good order and predictability on United States waterways by implementing fundamental waterways management practices.

Using PWSA as the authority and the San Francisco Harbor Advisory Radar as the operational model, the Coast Guard began to establish VTSs in critical, congested ports. San Francisco was formally established along with Puget Sound (Seattle) in 1972; Louisville, KY which is only activated during high water in the Ohio River (approximately 50 days per year) was started in 1973; Houston-Galveston, Prince William Sound; Berwick Bay (Louisiana) and the St. Mary's River at Sault Ste Marie, MI. New Orleans and New York provided services on a voluntary basis throughout the 1970-80's, however; these operations were curtailed in 1988 due to budgetary restraints. And, brought back on-line subsequent to the EXXON VALDEZ disaster, when the Coast Guard was mandated by the Oil Pollution Act of 1990 to make participation mandatory at existing and future VTSs.

2909. U.S. Operational Systems

The Coast Guard operates 12 Vessel Traffic Centers (VTC): Prince William Sound (Valdez), Puget Sound/Seattle, San Francisco, Los Angeles/Long Beach, Houston/Galveston, Berwick Bay, Louisville, Saint Mary's River, Lower Mississippi River, Port Arthur, Tampa, and New York. Each center is discussed in greater detail in the paragraphs below.

VTS New York has the responsibility of coordinating vessel traffic movements in the busy ports of New York and New Jersey. The VTS New York area includes the entrance to the harbor via Ambrose and Sandy Hook Channels, through the Verrazano Narrows Bridge to the Throgs Neck Bridge in the East River, to the Holland Tunnel in the Hudson River, the Kill Van Kull including Newark Bay and all of Arthur Kill, and Raritan Bay.

The current operation uses surveillance data provided by several radar sites, AIS and three closed circuit TV sites.

VTS San Francisco was commissioned in August of 1972. When the original radar system became operational in May 1973, the control center for VTS San Francisco was shifted to the Yerba Buena Island. This center was designated a Vessel Traffic Center (VTC).

VTS San Francisco is responsible for the safety of vessel movements along approximately 133 miles of waterway from offshore to the ports of Stockton and Sacramento. On 3 May 1995, federal regulations went into effect establishing regulated navigation areas within the San Francisco Bay Region. These regulations, developed with input from the Harbor Safety Committee of the San Francisco Bay Region, were designed to improve navigation safety by organizing traffic flow patterns; reducing meeting, crossing, and overtaking situations in constricted channels; and by limiting vessels' speeds. Major components of the system include a Vessel Traffic Center (at Yerba Buena Island), two high resolution radars, AIS, a VHF-FM communications network, a traffic separation scheme, and a **Vessel Movement Reporting System (VMRS)** which is the system used to monitor and track vessels movements within a VTS or VMRS area.

VTS San Francisco also operates an **Offshore Vessel Movement Reporting System (OVMRS)**. The OVMRS is completely voluntary and operates using a broadcast system with information provided by participants.

VTS Puget Sound became operational in September 1972 as the second Vessel Traffic Service. It collected vessel movement report data and provided traffic advisories by means of a VHF-FM communications network. In this early service a VMRS was operated in conjunction with a Traffic Separation Scheme (TSS), without radar surveillance. Operational experience gained from this service and VTS San Francisco soon proved the expected need for radar surveillance in those services with complex traffic flow.

In 1973 radar coverage in critical areas of Puget Sound was provided. Efforts to develop a production generation of radar equipment for future port development were initiated. To satisfy the need for immediate radar coverage, redundant military grade Coast Guard shipboard radar transceivers were installed at four Coast Guard light stations along the Admiralty Inlet part of Puget Sound. Combination microwave radio link and radar antenna towers were installed at each site. Radar video and azimuth data, in a format similar to that used with VTS San Francisco, were relayed by broad band video links to the VTC in Seattle. At that center, standard Navy shipboard repeaters were used for operator display. Although the resolution parameters and display accuracy of the equipment were less than those of the VTS San Francisco equipment, the use of a shorter range scale (8 nautical miles) and overlapping coverage resulted in very satisfactory operation. In December 1980 additional radar surveillance was added in the Strait of Juan De Fuca and Rosario Strait, as well as increased surveillance of the Seattle area, making a total of 10 remote radar sites.

The communications equipment was upgraded in July 1991 to be capable of a two frequency, four sector system. Channels 5A and 14 are the frequencies for VTS Puget Sound. A total of 13 communication sites are in operation (3 extended area sites, 10 low level sites). The three extended area sites allow the VTS the ability to communicate in a large area when needed. The low level sites can be used in conjunction with one another without interference, and have greatly reduced congestion on the frequency. VTS Puget Sound now covers the Strait of Juan de Fuca, Rosario Strait, Admiralty Inlet, and Puget Sound south as far as Olympia.

The major components of the system include the Vessel Traffic Center at Pier 36 in Seattle, a VHF-FM communications network, a traffic separation scheme, radar surveillance of about 80% of the VTS area, AIS and a Vessel Movement Reporting System. Regulations are in effect which require certain classes of vessels to participate in the system and make movement reports at specified points. The traffic separation scheme in the Strait of Juan de Fuca was extended as far west as Cape Flattery in March 1975 in cooperation with Canada and was formally adopted by the International Maritime Organization in 1982.

Since 1979, the U.S. Coast Guard has worked cooperatively with the Canadian Coast Guard in managing vessel traffic in adjacent waters. Through the **Cooperative Vessel Traffic Service (CVTS)**, two Canadian Vessel Traffic Centers work hand in hand with Puget Sound Vessel Traffic Service. Prince Rupert MCTS (Marine Communications and Traffic Services) manages the area west of the Strait of Juan de Fuca. North of the Strait of Juan de Fuca, through Haro Strait, to Vancouver, B.C. is managed by VICTORIA MCTS. The three Vessel Traffic Centers communicate via a computer link and dedicated telephone lines to advise each other of vessels passing between their respective zones.

VTS Houston-Galveston became operational in February 1975 as the third U.S. Vessel Traffic Service. The Vessel Traffic Center is located at Sector Houston-Galveston in Southeast Houston. The VTS operating area includes the Houston Ship Channel from the sea buoy to the Buffalo Bayou Turning Basin, Galveston Channel, Texas City Channel, Bayport Ship Channel, Barbours Terminal Channel, and 10 miles of the ICW. The area contains more than 70 miles of restricted waterways. The main part of the Houston Ship Channel is 530 feet wide with a depth of 45 feet. Several bends in the channel are in excess of 90 degrees.

The major components of the system include the VTC at Galena Park, Houston; a VHF-FM communications network; low light level, closed circuit television (LLL-CCTV) surveillance covering approximately three miles south of Morgan's Point west through the ship channel to City Dock #27 in Houston; a Vessel Movement Reporting System; and a radar surveillance system covering lower Galveston Bay approaches, Bolivar Roads, and Lower Galveston Bay.

A second radar was installed in 1994. This radar provides surveillance coverage between the Texas City channel and Morgan's Point. The entire VTS area is covered by AIS.

VTS Prince William Sound is required by The Trans-Alaska Pipeline Authorization Act (Public Law 93-153), pursuant to authority contained in Title 1 of the Ports and Waterways Safety Act of 1972 (86 Stat. 424, Public Law 92-340).

The Vessel Traffic Center is located in Valdez. The Coast Guard has installed a dependent surveillance system to improve its ability to track tankers transiting Prince William Sound and requires these vessels to carry position and identification reporting equipment. The ability to supplement radar with dependent surveillance bridges the gap in areas where conditions dictate some form of surveillance and where radar coverage is impractical. Once the dependent surveillance information is returned to the vessel traffic center, it is integrated with radar data and presented to the watchstander on an electronic chart display.

The system is composed of two radars, two major microwave data relay systems, and a VMRS which covers Port Valdez, Prince William Sound, and Gulf of Alaska. There is also a vessel traffic separation scheme from Cape Hinchinbrook to Valdez Arm.

The Coast Guard installed a dependent surveillance system to improve its ability to track tankers transiting Prince William Sound, however, that system was ultimately retired and replaced by AIS.

The southern terminus of the pipeline is on the south shoreline of the Port of Valdez, at the Alyeska Pipeline Service Company tanker terminal. Port Valdez is at the north end of Prince William Sound, and Cape Hinchinbrook is at the south entrance. Geographically, the area is comprised of deep open waterways surrounded by mountainous terrain. The only constrictions to navigation are at Cape Hinchinbrook, the primary entrance to Prince William Sound, and at Valdez Narrows, the entrance to Port Valdez.

VTS Saint Mary's River has been operational since October 1994 when it became a mandatory system operating year-round with an area of responsibility encompassing the entire length of the St. Mary's River (Approx. 80 miles).

On March 6, 1896, Title 33 USC 474 directed the Commandant of the Revenue Cutter Service to prescribe appropriate rules and regulations regarding the movement and anchorage of vessels and rafts in the St Marys River from Point Iroquois on Lake Superior to Point Detour on Lake Huron. This marked the beginning of the St Marys River Vessel Traffic Service (VTS). Originally named the River Patrol Service, this fledgling VTS operation was initially comprised of the Revenue Cutter MORRELL and Lookout Stations at Johnson's Pt (#1), Middle Neebish Dyke (#2) and Little Rapids Cut (#3). The stations were connected by telegraph lines linked back to the Pittsburgh Steamship Company offices in Sault Sainte Marie, MI. "Soo Control", the call sign for the original traffic management control center, evolved into a vessel movement reporting system which relied heavily on mariners to provide information on traffic flow and hazards. Formerly renamed the Vessel Traffic Service in 1975, VTS St. Marys River was initially a voluntary vessel movement reporting system.

The St Marys River is a complex waterway. It features strong currents, wind driven water level fluctuations and narrow channels which challenge the most seasoned of navigators. Within the VTS area the water level drops approx. 21 feet from the level of Lake Superior to the level of the lower lakes. Thus, the Soo Locks were constructed and are presently maintained by the Corps of Engineers. In most of the areas of the river there is adequate room for vessels to maneuver or anchor during periods of low visibility, or when other problems hinder safe navigation. However, there are three areas extremely hazardous to transit or anchor in low visibility: West Neebish Channel (down-bound traffic only), Middle Neebish Channel (Up-bound traffic only), and Little Rapids Cut (two-way traffic). During periods of low visibility it is customary to close the entire river. Today VTS St. Marys River, a sub unit of Sector Sault Sainte Marie, maintains close alliances with their Canadian counterparts in Sarnia Ontario, the Army Corps of Engineers and the Great Lakes Maritime Industry. Coordination among these key players is paramount particularly during the ice breaking season. Each winter when plate ice can reach a thickness of three to five feet, the cooperation and exchange of information fostered by these corporate and governmental partnerships is the key to the safe and efficient movement of commercial interests.

VTS Lower Mississippi River is a component of the Waterway Division of USCG Sector New Orleans. VTS Lower Mississippi River manages vessel traffic on one of the most hazardous waterway in the United States due to the complexity of the marine traffic and the powerful currents of the Mississippi River. The Vessel Traffic Center is located in a high rise office building in the New Orleans Central Business District. Its area of responsibility spans from twenty miles above the Port of Baton Rouge (Mile 255 above the Head of the Passes) to twelve miles offshore of Southwest Pass Light in the Gulf of Mexico. Within this VTS service area the VTS monitors the Eighty One Mile Point Regulated Navigation Area (Mile 187.9 to Mile 167 Ahead of Passes) and the New Orleans Harbor Sector (Mile 106 to Mile 88). The VTS provides advisory and navigational assistance services at all times in these areas of responsibility. When the river reaches high water levels of eight feet in New Orleans, the VTS controls traffic at the Algiers Point Special Area (Mile 93.5 to Mile 95). VTS Lower Mississippi River is a unique Coast Guard Vessel Traffic Service because it maintains advisory service and direct control of vessel traffic with a workforce of highly trained and experienced civilian Coast Guard personnel with the assistance of pilot advisors.

VTS Berwick Bay manages vessel traffic on another hazardous waterway influenced by strong currents and a series of bridges that must be negotiated by inland tows traveling between Houston, Baton Rouge and New Orleans. The Vessel Traffic Center is located at Coast Guard Marine Safety Office Morgan City, LA. Its area of responsibility encompasses the junction of the Atchafalaya River (an outflow of the Mississippi River), the Gulf Intracoastal Waterway, the Port Allen-Morgan City Alternate Route and several tributary bayous. Narrow bridge openings and a swift river current require the VTS to maintain one-way traffic flow through the bridges. During seasonal high water periods, the VTS enforces towing regulations that require inland tows transiting the bridges to have a minimum amount of horsepower based on the length of tow. VTS Berwick Bay is unique among Coast Guard Vessel Traffic Services because it maintains direct control of vessel traffic.

VTS Port Arthur actively monitors all waters of the Sabine-Neches Waterway to Port Arthur, Beaumont, and Orange, TX, including the offshore fairway to the sea buoy, the east/west crossing offshore fairway extending 12 miles on either side of the main channel, and the Gulf Intracoastal Waterway from mile 260 to mile 295. This area is home to the Ports of Port Arthur, Beaumont, and Orange, Texas. Additionally, it is the home of four large oil refineries, two Liquefied Natural Gas terminals, twenty-five percent of the nation's Strategic Petroleum Reserves, and the largest commercial military outload port in the U.S.

VTS Louisville is a vessel movement reporting system designed to enable vessel operators to better cope with problems encountered during high water on the Ohio River between miles 592.0 and 606.0. The VTS has four cameras surveying the waterway. It monitors traffic via VHF Channel 13 communications only. The VTS is activated when the upper river gauge at the McAlpine Lock and Dam is approximately 13.0 feet and rising. It remains in 24-hour operation until the upper river gauge falls below 13.0 feet. River conditions vary widely, especially during springtime. A series of thunderstorms can, at times, necessitate activation of the VTS in a matter of hours.

VTS Tampa has the responsibility of coordinating vessel traffic movements in the busy ports of Tampa, Manatee, and St. Petersburg. VTS Tampa's area includes the entrance to Tampa Bay via Egmont and Mullet Key Channels, the Sunshine Skyway Bridge, Old Tampa Bay, Hillsborough Bay, and the waters surrounding MacDill Air Force Base.

VTS Los Angeles/Long Beach assists in the safe navigation of vessels approaching the ports of LA/LB in an area extending 25 miles out to sea from Point Fermin (LAT 33 42.3'N LONG 118 17.6'W). The LA/LB VTS developed a unique partnership with the state of California, the Coast Guard, the Ports of Los Angeles-Long Beach, the Marine Exchange, and the local maritime community. With start up funds provided by the ports of Los Angeles and Long Beach, the VTS operations are supported by fees assessed against commercial vessels operating in the LA/LB area.

2910. Vessel Traffic Management and Information Systems

An emerging concept is that of Vessel Traffic Management and Information Services (VTMIS) wherein a VTS is only part of a larger and much more comprehensive information exchange. Under this concept, not only can vessel traffic be managed from the standpoint of navigation safety and efficiency, but also tugs, pilots, line handlers, intermodal shipping operators, port authorities, customs and immigration, law enforcement, and disaster response agencies and others can use vessel transit information to enhance the delivery of their services.

A VTS need not be part of a VTMIS, but it is logical that no port needing the latter would be without the former. It is important to note that VTMIS is a service, not a system, and requires no particular set of equipment or software. VTMIS development and installations are proceeding in several busy ports and waterways worldwide, and mariners can expect this concept to be implemented in many more areas in the future.

REGULATED WATERWAYS

2911. Purpose and Authorities

In confined waterways not considered international waters, local authorities may establish certain regulations for the safe passage of ships and operate waterway systems consisting of locks, canals, channels, and ports. This generally occurs in especially busy or highly developed waterways which form the major constrictions on international shipping routes. The Panama Canal, St. Lawrence Seaway, and the Suez Canal represent systems of this type. Nearly all ports and harbors have a body of regulations concerning the operation of vessels within the port limits, particularly if locks and other structures are part of the system. The regulations covering navigation through these areas are typically part of a much larger body of regulations relating to assessment and payment of tariffs and tolls, vessel condition and equipment, personnel, communications equipment, and many other factors. In general, the larger the investment in the system, the larger the body of regulations which control it will be.

Where a waterway separates two countries, a joint authority may be established to administer the regulations, collect tolls, and operate the system, as in the St. Lawrence Seaway.

Copies of the regulations are usually required to be aboard each vessel in transit. These regulations are available from the authority in charge or an authorized agent. Summaries of the regulations are contained in the appropriate volumes of the *Sailing Directions (Enroute)*.

CHAPTER 30

MARITIME SAFETY SYSTEMS

MARITIME SAFETY AND THE NAVIGATOR

3000. Introduction

The navigator's chief responsibility is the safety of the vessel and its crew. Fulfilling this duty consists mostly of ascertaining the ship's position and directing its course to avoid dangers. But accidents can happen to the most cautious, and the most prudent of navigators may experience an emergency which requires outside assistance. Distress incidents at sea are more likely to be resolved without loss of vessel and life if they are reported immediately. The more information that rescue authorities have, and the sooner they have it, the more likely it is that the outcome of a distress at sea will be favorable.

Global distress communication systems, ship reporting systems, emergency radiobeacons, commercial ship tracking and other technologies have greatly enhanced mariners' safety. Therefore, it is critical that mariners understand the purpose, functions, and limitations of maritime safety systems as well as threats to maritime security.

The mariner's direct high-seas link to shoreside rescue authorities is the **Global Maritime Distress and Safety System (GMDSS),** which was developed to both simplify and improve the dependability of communications for all ships at sea. GMDSS nicely compliments the operation of the U.S. Coast Guard's AMVER system, which tracks participating ships worldwide and directs them as needed to distress incidents. GMDSS and AMVER rely on radiotelephone or satellite communications for passing information. But even with normal communications disabled, a properly equipped vessel has every prospect of rapid rescue or aid if it carries a SOLAS-required Emergency Position Indicating Radiobeacon (EPIRB) and a Search and Rescue radar Transponder (SART). These systems are the subject of this chapter.

GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM

3001. Introduction and Background

The Global Maritime Distress and Safety System (GMDSS) represents a significant improvement in maritime safety over the previous system of short range and high seas radio transmissions. Its many parts include satellite as well as advanced terrestrial communications systems. Operational service of the GMDSS began on February 1, 1992, with full implementation accomplished by February 1, 1999.

GMDSS was adopted in 1988 by amendments to the Conference of Contracting Governments to the **International Convention for the Safety of Life at Sea (SOLAS)**, 1974. This was the culmination of more than a decade of work by the International Maritime Organization (IMO) in conjunction with the International Telecommunications Union (ITU), International Hydrographic Organization (IHO), World Meteorological Organization (WMO), Inmarsat (International Maritime Satellite Organization), and others.

GMDSS offers the greatest advancement in maritime safety since the enactment of regulations following the Titanic disaster in 1912. It is an automated ship-to-ship, shore-to-ship and ship-to-shore communications system covering distress alerting and relay, the provision of **maritime safety information (MSI)**, and routine communications. Satellite and advanced terrestrial systems are incorporated into a communications network to promote and improve safety of life and property at sea throughout the world. The equipment required on board ships depends on their tonnage and the area in which the vessel operates. This is fundamentally different from the previous system, which based requirements on vessel size alone. The greatest benefit of the GMDSS is that it vastly reduces the chances of ships sinking without a trace, and enables **search and rescue (SAR)** operations to be launched without delay and directed to the exact site of a maritime disaster.

3002. Ship Carriage Requirements

By the terms of the SOLAS Convention, the GMDSS provisions apply to cargo ships of 300 gross tons and over and ships carrying passengers on international voyages. Unlike previous shipboard carriage regulations that specified equipment according to size of vessel, the GMDSS carriage requirements stipulate equipment according to the area in which the vessel operates (and vessel size in some cases). These sea areas are designated as follows:

Sea Area A1 An area within the radiotelephone coverage of at least one VHF coast station in which continuous Digital Selective Calling is available, as may be defined by a Contracting Government to the 1974 SOLAS Convention. This area extends from the coast to about 20 miles offshore.

Sea Area A2 An area, excluding sea area A1, within the radiotelephone coverage of at least one MF coast station in which continuous DSC alerting is available, as may be defined by a Contracting Government. The general area is from the A1 limit out to about 100 miles offshore.

Sea Area A3 An area, excluding sea areas A1 and A2, within the coverage of an Inmarsat geostationary satellite in which continuous alerting is available. This area is from about 70°N to 70°S.

Sea Area A4 All areas outside of sea areas A1, A2 and A3. This area includes the polar regions, where geostationary satellite coverage is not available.

Ships at sea *must* be capable of the following functional GMDSS requirements:

1. Ship-to-shore distress alerting, by at least two separate and independent means, each using a different radio communication service
2. Shore-to-ship distress alerting
3. Ship-to-ship distress alerting
4. SAR coordination
5. On-scene communications
6. Transmission and receipt of emergency locating signals
7. Transmission and receipt of MSI
8. General radio communications
9. Bridge-to-bridge communications

To meet the requirements of the functional areas above the following is a list of the minimum communications equipment needed for all ships:

1. VHF radio capable of transmitting and receiving DSC on channel 70, and radio telephony on channels 6, 13 and 16
2. Radio receiver capable of maintaining a continuous Digital Selective Calling (DSC) watch on channel 70 VHF
3. Search and rescue transponders (SART). Only one SART is required if the vessel is under 500 gross tons. Two SARTs are required if the vessel is over 500 tons and must be capable of operating in the 9 GHz band (AIS SART meets carriage requirements).
4. Receiver capable of receiving NAVTEX broadcasts anywhere within NAVTEX range
5. Receiver capable of receiving SafetyNET anywhere NAVTEX is not available
6. Satellite emergency position indicating radiobeacon (EPIRB), manually activated and float-free self-activated
7. Two-way handheld VHF radios (two sets minimum on 300-500 gross tons cargo vessels and three sets minimum on cargo vessels of 500 gross tons and upward and on all passenger ships)

Additionally, each sea area has its own requirements under GMDSS which are as follows:

Sea Area A1

1. General VHF radio telephone capability
2. Free-floating satellite EPIRB
3. Capability of initiating a distress alert from a navigational position using DSC on either VHF, HF or MF; manually activated EPIRB; or Ship Earth Station (SES)

Sea Areas A1 and A2

1. Radio telephone MF radiotelephony or direct printing 2182 kHz, and DSC on 2187.5 kHz
2. Equipment capable of maintaining a continuous DSC watch on 2187.5 kHz
3. General working radio communications in the MF band (1605-4000 kHz), or Inmarsat SES
4. Capability of initiating a distress alert by HF (using DSC), manual activation of an EPIRB, or Inmarsat SES

Sea Areas A1, A2 and A3

1. Radio telephone MF 2182 kHz and DSC 2187.5 kHz.
2. Equipment capable of maintaining a continuous DSC watch on 2187.5 kHz
3. Inmarsat-C (class 2) or Fleet 77 SES Enhanced Group Call (EGC), or HF as required for sea area A4
4. Capability of initiating a distress alert by two of the following:
   a. Inmarsat-C (class 2) or Fleet 77 SES
   b. Manually activated EPIRB
   c. HF/DSC radio communication

Sea Area A4

1. HF/MF receiving and transmitting equipment for band 1605-27500 kHz using DSC, radiotelephone and direct printing
2. Equipment capable of selecting any safety and distress DSC frequency for band 4000-27500 kHz,

maintaining DSC watch on 2187.5, 8414.5 kHz and at least one additional safety and distress DSC frequency in the band
3. Capability of initiating a distress alert from a navigational position via the Polar Orbiting System on 406 MHz (manual activation of 406 MHz satellite EPIRB)

3003. The Inmarsat System

Inmarsat (International Maritime Satellite Organization), a key player within GMDSS, is an international corporation comprising over 75 international partners providing maritime safety communications for ships at sea. Inmarsat provides the space segment necessary for improving distress communications, efficiency and management of ships, as well as public correspondence services.

The basic components of the Inmarsat system include the Inmarsat **space segment, Land Earth Stations (LES)**, also referred to as **Coast Earth Stations (CES)**, and mobile **Ship Earth Stations (SES)**.

The Inmarsat space segment consists of 11 geostationary satellites. Four operational Inmarsat satellites provide primary coverage, four additional satellites (including satellites leased from the European Space Agency (ESA) and the International Telecommunications Satellite Organization (INTELSAT)) serve as spares and three remaining leased satellites serve as back-ups.

The polar regions are not visible to the operational satellites but coverage is available from about 75°N to 75°S. Satellite coverage (Figure 3003) is divided into four overlapping regions:

1. Atlantic Ocean - East (AOR-E)
2. Atlantic Ocean - West (AOR-W)
3. Pacific Ocean (POR)
4. Indian Ocean (IOR)

The LES's provide the link between the Space Segment and the land-based national/international fixed communications networks. These communications networks are funded and operated by the authorized communications authorities of a participating nation. This network links registered information providers to the LES. The data then travels from the LES to the Inmarsat **Network Coordination Station (NCS)** and then down to the SES's on ships at sea. The SES's provide two-way communications between ship and shore. Fleet 77 service is digital and operates at up to 64kbps.

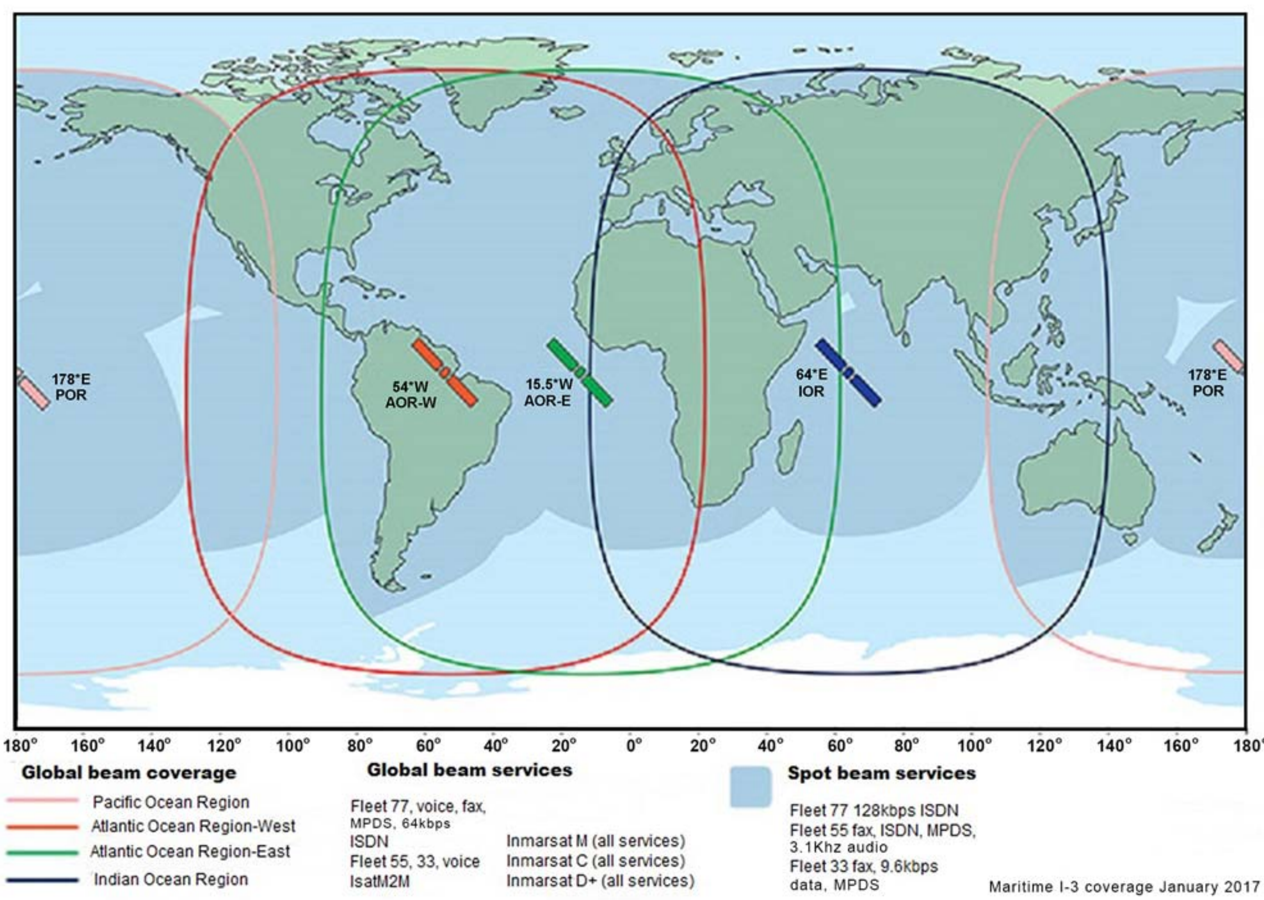

Figure 3003. The four regions of Inmarsat coverage.

Inmarsat-C provides a two-way **store and forward** data messaging capability (but no voice) at 600 bits per second and was designed specifically to meet the GMDSS requirements for receiving MSI data on board ship. These units are small, lightweight and use an omni-directional antenna.

3004. Maritime Safety Information (MSI)

Major categories of MSI for both NAVTEX and SafetyNET are:

1. Navigational warnings
2. Meteorological warnings
3. Ice reports
4. Search and rescue information
5. Meteorological forecasts
6. Pilot service messages (not in the U.S.)
7. Electronic navigation system messages (i.e., GPS, DGPS, etc.)

Broadcasts of MSI in NAVTEX international service are in English, but may be in languages other than English to meet requirements of the host government.

3005. SafetyNET

SafetyNET is a broadcast service of Inmarsat-C's **Enhanced Group Call (EGC)** system. The EGC system (Figure 3005a) is a method used to specifically address particular regions or groups of ships. Its unique addressing capabilities allow messages to be sent to all vessels in both fixed geographical areas or to predetermined groups of ships. SafetyNET is a service designated by the IMO through which ships receive maritime safety information. The other service under the EGC system, called **FleetNET**, is used by commercial companies to communicate directly and privately with their individual fleets.

SafetyNET is an international shore to ship satellite-based service for the promulgation of distress alerts, navigational warnings, meteorological warnings and forecasts, and other safety messages. It fulfills an integral role in GMDSS as developed by the IMO. The ability to receive SafetyNET messages is required for all SOLAS ships that sail beyond coverage of NAVTEX (approximately 200 miles from shore).

SafetyNET can direct a message to a given geographic area based on EGC addressing. The area may be fixed, as in the case of a NAVAREA or weather forecast area, or it may be uniquely defined by the originator. This is particularly useful for messages such as local storm warnings or focused shore to ship distress alerts.

SafetyNET messages can be originated by a **Registered Information Provider** anywhere in the world and broadcast to the appropriate ocean area through an Inmarsat-C LES. Messages are broadcast according to their priority (i.e. Distress, Urgent, Safety, and Routine).

Virtually all navigable waters of the world are covered by the operational satellites in the Inmarsat system. Each satellite broadcasts EGC traffic on a designated channel. Any ship sailing within the coverage area of an Inmarsat satellite will be able to receive all the SafetyNET messages broadcast over this channel. The EGC channel is optimized to enable the signal to be monitored by SES's dedicated to the reception of EGC messages. This capability can be built into other standard SES's. It is a feature of satellite communications that reception is not generally affected by the position of the ship within the ocean region, atmospheric conditions, or time of day.

Messages can be transmitted either to geographic areas (area calls) or to groups of ships (group calls):

1. **Area calls** can be to a fixed area such as one of the 16 NAVAREA's or to a temporary geographic area selected by the originator (circular or rectangular). Area calls will be received automatically by any ship whose receiver has been set to one or more fixed areas.

2. **Group calls** will be received automatically by any ship whose receiver acknowledges the unique group identity associated with a particular message.

Reliable delivery of messages is ensured by forward error correction techniques. Experience has demonstrated that the transmission link is generally error-free and low error reception is achieved under normal circumstances.

Given the vast ocean coverage by satellite, some form of discrimination and selectivity in printing the various messages is required. Area calls are received by all ships within the ocean region coverage of the satellite; however, they will be printed only by those receivers that recognize the fixed area or the geographic position in the message. The message format includes a **preamble** that enables the microprocessor in a ship's receiver to decide to print those MSI messages that relate to the present position, intended route or a fixed area programmed by the operator. This preamble also allows suppression of certain types of MSI that are not relevant to a particular ship. As each message will also have a unique identity, the reprinting of messages already received correctly is automatically suppressed.

MSI is promulgated by various information providers around the world. Messages for transmission through the SafetyNET service will, in many cases, be the result of coordination between authorities. Information providers will be authorized by IMO to broadcast via SafetyNET. Authorized information providers are:

1. National hydrographic offices for navigational warnings
2. National weather services for meteorological warnings and forecasts
3. Rescue Coordination Centers (RCC's) for ship-to-shore distress alerts and other urgent information

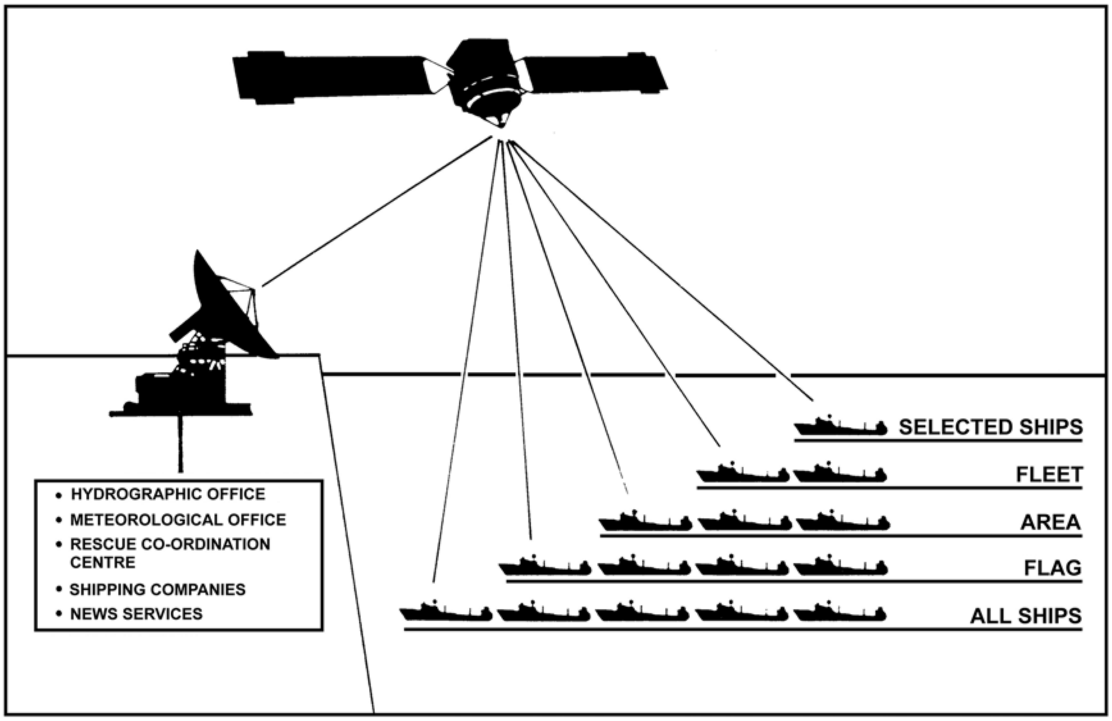

Figure 3005a. SafetyNET EGC concept.

4. In the U.S., the International Ice Patrol (IIP) for North Atlantic ice hazards

Each information provider prepares their SafetyNET messages with certain characteristics recognized by the EGC service. These characteristics, known as “C” codes are combined into a generalized message header format as follows: C1:C2:C3:C4:C5. Each “C” code controls a different broadcast criterion and is assigned a numerical value according to available options. A sixth “C” code, “C0” may be used to indicate the ocean region (i.e., AOR-E, AOR-W, POR, IOR) when sending a message to an LES which operates in more than one ocean region. Because errors in the header format of a message may prevent its being broadcast, MSI providers must install an Inmarsat SafetyNET receiver to monitor the broadcasts it originates. This also ensures quality control.

The “C” codes are transparent to the mariner, but are used by information providers to identify various transmitting parameters. C1 designates the message priority, either distress to urgent, safety, or routine. MSI messages will always be at least at the safety level. C2 is the service code or type of message (for example, long range NAVAREA warning or coastal NAVTEX warning). It also tells the receiver the length of the address (the C3 code) it will need to decode. C3 is the address code. It can be the two-digit code for the NAVAREA number for instance, or a ten-digit number to indicate a circular area for a meteorological warning. C4 is the repetition code which instructs the LES when to send the message to the NCS for actual broadcast. A six minute echo (repeat) may also be used to ensure that an urgent (unscheduled) message has been received by all ships affected. C5 is a constant and represents a presentation code, International Alphabet number 5, “00”.

Broadcasts of MSI in the international SafetyNET service must be in English, but may be supplemented by other languages to meet requirements of the host government.

The International SafetyNET Manual is available on-line via the link provided in Figure 3005b.

Figure 3005b. International SafetyNET Manual.
https://www.iho.int/mtg_docs/com_wg/CPRNW/WWNWS1/WWNWS1-4-3-1.doc

3006. NAVTEX

NAVTEX is a maritime radio warning system consisting of a series of coast stations transmitting radio teletype (standard narrow-band direct printing, called **Sitor** for Simplex Telex Over Radio) safety messages on the internationally standard medium frequency of 518 kHz (490kHz local language). It is a GMDSS requirement for the reception of MSI in coastal and local waters. Coast stations transmit during previously arranged time slots to minimize mutual interference. Routine messages are normally broadcast four times daily. Urgent messages are broadcast upon receipt, provided that an adjacent station is not transmitting. Since the broadcast uses the medium frequency band, a typical station service radius ranges from 100 to 500 NM day and night (although a 200 mile rule of thumb is applied in the U.S.). Interference from or receipt of stations further away occasionally occurs at night.

Each NAVTEX message broadcast contains a four-character header describing: identification of station (first character), message content or type (second character), and message serial number (third and fourth characters). This header allows the microprocessor in the shipboard receiver to screen messages from only those stations relevant to the user, messages of subject categories needed by the user and messages not previously received by the user. Messages so screened are printed as they are received, to be read by the mariner when convenient. All other messages are suppressed. Suppression of unwanted messages is becoming more and more a necessity to the mariner as the number of messages, including rebroadcast messages, increases yearly. With NAVTEX, a mariner will not find it necessary to listen to, or sift through, a large number of non-relevant data to obtain the information necessary for safe navigation.

The NAVTEX receiver is a small unit with an internal printer, which takes a minimum of room on the bridge. Its antenna is also of modest size, needing only a receive capability.

Valuable information regarding NAXTEX and navigational warnings can be found in *Pub No. 117 Radio Navigation Aids* via the link provided in Figure 3006.

Figure 3006. NGA- Radio Navigational Aids (Pub. No. 117).
https://msi.nga.mil/NGAPortal/MSI.portal?_nfpb=true&_st=&_pageLabel=msi_portal_page_62&pubCode=0009

3007. Digital Selective Calling (DSC)

Digital Selective Calling (DSC) is a system of digitized radio communications which allows messages to be targeted to all stations or to specific stations, allows for unattended and automated receipt and storage of messages for later retrieval, and permits the printing of messages in hardcopy form. All DCS calls automatically include error-checking signals and the identity of the calling unit. Digital codes allow DSC stations to transmit and receive distress messages, transmit and receive acknowledgments of distress messages, relay distress messages, make urgent and safety calls, and initiate routine message traffic.

Each unit has a MAYDAY button which allows the instant transmittal of a distress message to all nearby ships and shore stations. The location of the distress will be automatically indicated if the unit is connected to a GPS receiver. Each unit must be registered with the Coast Guard and have unique identifier programmed into it. Distress alerts can be sent on only one or as many as six channels consecutively on some units.

Listening watch on 2182 kHz ended with implementation of GMDSS in 1999. When DSC has been implemented worldwide, the traditional listening watch on Channel 16 VHF will no longer be necessary. The introduction of DSC throughout the world is expected to take to take a number of years.

There are four basic types of DSC calls:

- Distress
- Urgent
- Safety
- Routine

Distress calls are immediately received by rescue authorities for action, and all vessels receiving a distress call are alerted by an audible signal.

Each DSC unit has a unique **Maritime Mobile Service Identity (MMSI)** code number, which is attached to all outgoing messages. The MMSI number is a nine-digit number to identify individual vessels, groups of vessels, and coast stations. Ship stations will have a leading number consisting of 3 digits which identify the country in which the ship is registered, followed by a unique identifying number for the vessel. A group of vessels will have a leading zero, followed by a unique number for that group. A coast station will have 2 leading zeros followed by a code number. Other codes may identify all stations, or all stations in a particular geographic area.

DSC frequencies are found in the VHF, MF and HF bands. Within each band except VHF, one frequency is allocated for distress, urgent, and safety messages. Other frequencies are reserved for routine calls. In the VHF band, only one channel is available, Channel 70 (156.525 MHz), which is used for all calls. In the MF band, 2187.5 kHz and 2189.5 kHz are reserved for distress/safety, and 2177 kHz for ship-to-ship. 2189.5 kHz (in conjunction with 2177 kHz) is for routine ship-to-shore calls.

3008. Using DSC

A distress call consists of a Format Specifier--Distress; the MMSI code; the nature of the distress (selected from a list: fire/explosion, flooding, collision, grounding, listing, sinking, disabled/adrift, or abandoning ship; defaults to Undesignated); the time of the call, and the format for subsequent communications (radiotelephone or NDBP). Once activated, a distress signal is repeated automatically every few minutes until an acknowledgment is received or the function is switched off. As soon as an acknowledgment is received by the vessel in distress, it must commence communications with an appropriate message by radiotelephone or NDBP according to the format:

"MAYDAY"
MMSI CODE NUMBER AND CALL SIGN
NAME OF VESSEL
POSITION
NATURE OF DISTRESS
TYPE OF ASSISTANCE NEEDED
OTHER INFORMATION

Routine calls should be made on a channel reserved for non-distress traffic. Once made, a call should not be repeated, since the receiving station either received the call and stored it, or did not receive it because it was not in service. At least 5 minutes should elapse between calls by vessels on the first attempt, then at 15 minute minimum intervals.

To initiate a routine ship to shore or ship to ship call to a specific station, the following procedures are typical (consult the operator's manual for the equipment for specific directions):

- Select the appropriate frequency
- Select or enter the MMSI number of the station to be called
- Select the category of the call
- Select subsequent communications method (R/T, NDBP)
- Select proposed working channel (coast stations will indicate vacant channel in acknowledgment)
- Select end-of-message signal (RQ for acknowledgment required)
- Press <CALL>

The digital code is broadcast. The receiving station may acknowledge receipt either manually or automatically, at which point the working channel can be agreed on and communications begin.

Watchkeeping using DSC consists of keeping the unit ON while in the appropriate Sea Area. DSC watch frequencies are VHF Channel 70, 2187.5 kHz, 8414.5 kHz, and one HF frequency selected according to the time of day and season. Coast stations maintaining a watch on DCS channels are listed in NGA *Pub. 117 Radio Navigational Aids* and other lists of radio stations.

3009. The Automated Mutual-Assistance Vessel Rescue System (AMVER)

AMVER is an international maritime mutual assistance program that coordinates search and rescue efforts around the world. It is voluntary, free of charge, and endorsed by the IMO. The AMVER system is discussed in detail in Chapter 31. The AMVER website can be accessed through the link provided in Figure 3009.

Figure 3009. AMVER website. www.amver.com

EMERGENCY POSITION INDICATING RADIOBEACONS (EPIRBS)

3010. Description and Capabilities

Emergency Position Indicating Radiobeacons (EPIRBs) are designed to save lives by automatically alerting rescue authorities and indicating the distress location. EPIRB types are described below (Table 3010a):

121.5/243 MHz EPIRBs (Class A, B, S): As of 1 January, 2007 the operation of 121.5 MHz EPIRBs has been prohibited in the United States. Satellite monitoring of the 121.5 MHz and 243.0 MHz frequencies was ceased 1 February, 2009.

All mariners using emergency beacons on either of these frequencies will need to upgrade to beacons operating on the newer, more reliable, 406 MHz digital EPIRBs in order to be detected by satellites.

406 MHz EPIRBs (Category I, II): The 406 MHz EPIRB was designed to operate with satellites. Its signal allows authorities to locate the EPIRB much more accurately than 121.5/243 MHz devices and identify the individual vessel anywhere in the world. There is no range limitation. These devices also include a 121.5 MHz homing signal, allowing aircraft and rescue vessels to quickly locate the vessel in distress once underway. These are the only type of EPIRB which must be tested by Coast Guard-approved independent laboratories before they can be sold for use in the United States.

An automatically activated, float-free version of this EPIRB has been required on SOLAS vessels (cargo ships over 300 tons and passenger ships on international voyages) since August 1, 1993. The Coast Guard requires U.S. commercial fishing vessels to carry this device, and requires the same for other U.S. commercial uninspected vessels which travel more than 3 miles offshore.

Owners of 406 MHz EPIRBs furnish registration information about their vessel, type of survival gear, and emergency points of contact ashore, all of which greatly enhance the quality of the response. The database for U.S. vessels is maintained by the National Oceanographic and Atmospheric Administration, and is accessed worldwide by SAR authorities to facilitate SAR response.

Type	Frequency	Description
Category I	406 MHz	Float-free, automatically activated. Detectable by satellite anywhere in the world.
Category II	406 MHz	Similar to Category I, except manually activated.

Table 3010a. 406 MHz EPIRB classifications.

3011. Registering EPIRBs

EPIRB Registration data provides search and rescue authorities with contact and vessel information which they use solely to locate the user in an emergency. The data can cut down the time needed to confirm an EPIRB distress location or allow authorities to locate a vessel even in rare instances where the EPIRB location cannot be determined.

When registering ensure the EPIRBs 15-digit Unique Identification Number (UIN) is entered properly and validated with the EPIRBs checksum (if provided). The UIN is what links registration data to a specific EPIRB.

In the U.S. EPIRB registration is required by the Code of Federal Regulations in the US (Title 47, Part 80, Section 80.1061, Paragraph (f)). Failure to register can, in some instances, result in penalties and/or fines issued by the FCC.

EPIRBs can be registered with NOAA through one of the following methods:

- Register online at https://beaconregistration.noaa.gov/rgdb/
- Mail the original, signed registration form, available on the website or with your beacon literature, to NOAA at:

    NOAA
    SARSAT BEACON REGISTRATION
    NSOF, E/SPO53
    1315 East West Hwy
    Silver Spring, MD 20910

- Or, fax the signed form to NOAA at 301-817-4565.

If you have any questions or comments pertaining to beacon registration, please call 301-817-4515 or toll-free at 1-888-212-SAVE (7283), or you may email your question to the Beacon Registration Staff at beacon.registration@noaa.gov.

3012. Preventing False Alerts

False alerts, transmission of an alert signal by an activated COSPAS-SARSAT EPIRB in situations other than distress, can cause delays in the responses of rescue agencies and can potentially overwrite actual distress alerts in the satellite memory.

To prevent false alerts follow your manufacturer directions for mounting and testing the EPIRB.

If your EPIRB is accidentally activated turn it off and contact the U.S. Coast Guard to report the activation with your 15-digit UIN available.

Intentionally transmitting a false alert can result in fines and jail time.

3013. Disposing of EPIRBs

When disposing of an old or unneeded EPIRB precautions must be taken to prevent accidental transmission from the disposal site. Before disposal, consult with the EPIRB manufacturer's instructions for specific guidance on procedures and recommendations. Contacts for EPIRB manufacturers can be found at: https://www.cospas-sarsat.int/en/contacts-pro/contacts-details-all.

At a minimum the EPIRB battery should be removed, the EPIRB should be clearly labeled as inactive, and the EPIRB registration should be updated to reflect disposal of the unit.

When possible the components of the old EPIRB and the EPIRB batteries should be recycled at an appropriate facility.

3014. Testing EPIRB’s

EPIRB owners should periodically check for water tightness, battery expiration date, and signal presence. 406 MHz EPIRBs have a self-test function which should be used in accordance with manufacturers' instructions at least monthly.

3015. The Cospas-Sarsat System

COSPAS is a Russian acronym for "Space System for Search of Distressed Vessels"; SARSAT signifies "Search And Rescue Satellite-Aided Tracking." COSPAS-SARSAT is an international satellite-based search and rescue system established by the U.S., Russia, Canada, and France to locate emergency radiobeacons transmitting on the 406 MHz frequency. Since its inception in 1982, the COSPAS-SARSAT system (SARSAT satellite only) has contributed to saving over 39,000 lives.

The USCG receives data from Maritime Rescue Coordination Center (MRCC) stations and SAR Points of Contact (SPOC). See Table 3015.

Country	*Location*	*Designator*
Algeria	Algiers	ALMCC
Argentina	El Palomar	ARMCC
Australia	Canberra	AUMCC
Brazil	San Paulo	BBMCC
Canada	Trenton	CMCC
Chile	Santiago	CHMCC
China	Beijing	CNMCC
France	Toulouse	FMCC
Greece	Athens	GRMCC
Hong Kong	Hong Kong	HKMCC
India	Bangalore	INMCC
Italy	Bari	ITMCC
Indonesia	Jakarta	IONCC
ITDC	Taipei	TAMCC
Japan	Tokyo	JAMCC
Korea (Rep. of)	Incheon	KOMCC
New Zealand*	-	-
Nigeria	Abuja	NIMCC
Norway	Bodo	NMCC
Pakistan	Karachi	PAMCC
Peru	Calloa	PEMCC
Russian Federation	Moscow	CMC
Saudi Arabia	Jiddah	SAMCC
Singapore	Singapore	SIMCC
South Africa	Cape Town	ASMCC
Spain	Maspalomas	SPMCC
Thailand	Bangkok	THMCC
Turkey	Ankara	TRMCC
UAE	Abu Dhabi	UKMCC
United Kingdom	Kinloss	UKMCC
United States	Suitland	USMCC

* New Zealand's ground stations connect directly to Australia's AUMCC.

Table 3015. Participants in Cospas-Sarsat *system.*

3016. Operation of the Cospas-Sarsat System

When an EPIRB is activated, COSPAS/SARSAT picks up the signal, locates the source and passes the information to a land station. From there, the information is relayed to Rescue Coordination Centers, rescue vessels and nearby ships. This constitutes a one-way only communications system, from the EPIRB via the satellite to the rescuers. COSPAS/SARSAT instruments are carried by two satellite constellations which provide for global detection and location of emergency beacons. The Low Earth Orbit (LEO) constellation consists of low-altitude, near-polar orbiting satellites. These satellites exploit the Doppler principle to locate the 406 MHz EPIRB within approximately 5km.

As a LEO satellite approaches a transmitting EPIRB, the frequency of the signals it receives is higher than that being transmitted; when the satellite has passed the EPIRB, the received frequency is lower. This creates a notable Doppler shift. When the satellite approaches a ground station, known as a Local User Terminal (LUT), the LUT receives the recorded beacon frequency data from the satellite and then calculates the position of the EPIRB taking into account the Earth's rotation and other factors.

Because of the low orbit and small footprint of LEO satellites a satellite will pass overheard roughly every 45 minutes and delays are possible.

The Geo-stationary Earth Orbit (GEO) constellation consists of high-altitude satellites in orbits which keep them in a fixed location over the equator. The large footprint of GEO satellites complements the LEO constellation by providing for instantaneous detection of an active beacon anywhere in the world. However, as GEO satellites are stationary relative to the ground, they cannot independently locate a beacon.

Newer EPIRBs incorporate an additional GPS chip and use a protocol which encodes GPS coordinates into the beacon's digital transmission. The Geostationary segment of the SARSAT constellation retransmits the encoded message to ground stations, providing a near-instantaneous position which can minimize the delay in identifying the distress location.

Each 406 MHz EPIRB incorporates a unique identification code. Once the satellite receives the beacon's signals, the beacon's digital data is recovered from the signal, time-tagged, and transferred to the repeater downlink for real time transmission along with any Doppler frequency or position data to a LUT. The digital data coded into each 406 MHz EPIRBs memory indicates the identity of the vessel to SAR authorities. They can then refer to the EPIRB registration database for information about the type of vessel, survival gear carried aboard, whom to contact in an emergency, etc. The data includes a maritime identification digit (MID, a three digit number identifying the administrative country) and either a ship station identifier (SSI, a 6 digit number assigned to specific ships), a ship radio call sign or a serial number to identify the ship in distress.

See Figure 3016a for a graphical overview of the COSPAS-SARSAT system.

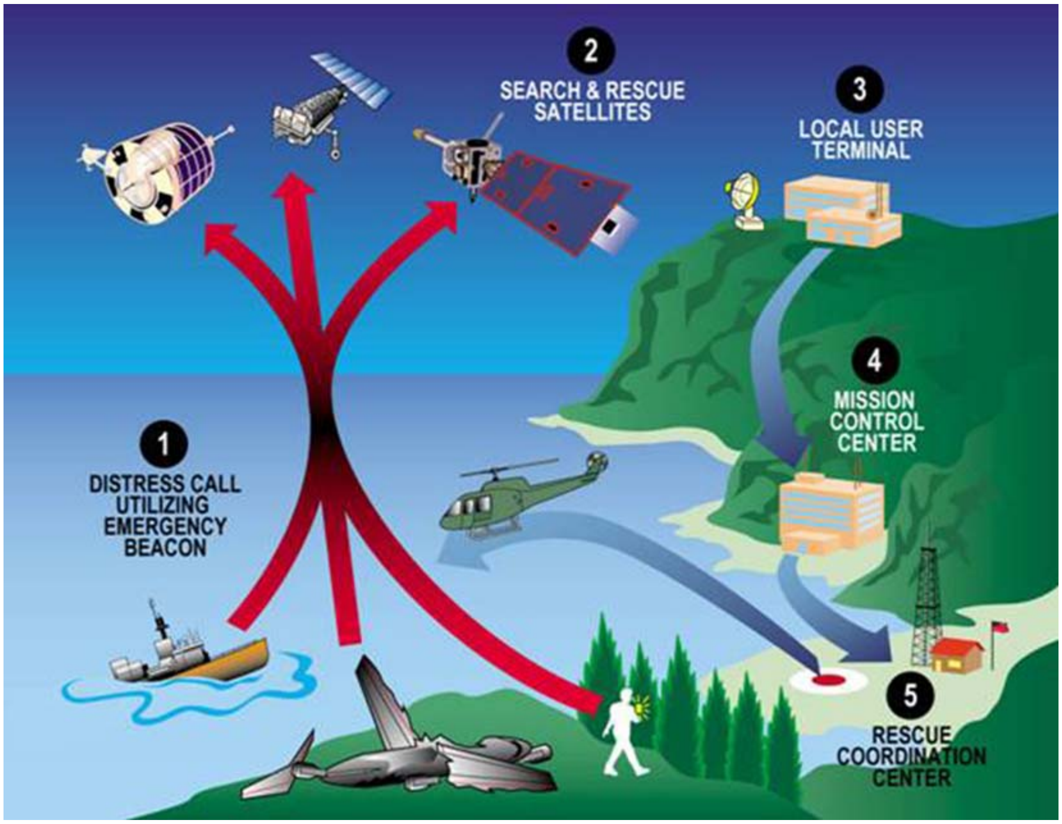

Figure 3016a. COSPAS-SARSAT System Overview. (1) Emergency locater transmitters (ELTs), EPIRBs, and personal locater beacons (PLBs) operate on the 406 MHz frequency. Each 406 MHz beacon transmits a unique digital code that identifies the type of beacon and that allows registration data to be associated with the beacon. The registration data provides information such as the beacon owner; the type of platform the beacon is associated with; emergency points of contact; and much more. (2) After the satellite receives a beacon signal, it relays the signal to ground stations referred to as local user terminals (LUTs). There are two types of LUTs: Low-Earth Orbiting LUTs (LEOLUTs) which receive and process alert data from the polar-orbiting satellites; and Geostationary LUTs (GEOLUTs) which receive and process alert data from geostationary satellites.(3) The LUT processes the data and transmits an alert message to its respective Mission Control Center (MCC) via a data communication network. (4) The MCC performs matching and merging of alert messages with other received messages, geographically sorts the data, and transmits a distress message to another MCC, an appropriate SAR authority such as a national Rescue Coordination Center (RCC) or a foreign SAR Point of Contact (SPOC). (5) The RCC investigates the beacon alert and launches assets to find the parties in distress when necessary.

3017. Alarm, Warning, and Alerting Signals

For MF (i.e. 2182 kHz), the signal consists of either (1) a keyed emission modulated by a tone of 1280 Hz to 1320 Hz with alternating periods of emission and silence of 1 to 1.2 seconds each; or (2) the radiotelephone alarm signal followed by Morse code B (— • • •) and/or the call sign of the transmitting ship, sent by keying a carrier modulated by a tone of 1300 Hz or 2200 Hz. For VHF (i.e. 121.5 MHz and 243 MHz), the signal characteristics are in accordance with the specifications of Appendix 37A of the ITU Radio Regulations. For 156.525 MHz and UHF (i.e. 406 MHz to 406.1 MHz and 1645.5 MHz to 1646.5 MHz), the signal characteristics are in accordance with CCIR recommendations.

The purpose of these signals is to help determine the position of survivors for SAR operations. They indicate that one or more persons are in distress, may no longer be aboard a ship or aircraft, and may not have a receiver available.

AUTOMATIC IDENTIFICATION SYSTEMS

3018. Development and Purpose

Automatic Identification System (AIS) is a navigation-communication protocol used in the maritime

VHF-FM band, to autonomously exchanges real-time navigation information amongst other AIS users or stations. Given that AIS is digital protocol, it facilitates that its data can -but not currently required to-be used or portrayed on other systems, such as ECDIS, radar, VTS monitors, personal computers, shore-side web services, etc.

Upon proliferation of regional (and disparate) tracking systems in the early 1990 (i.e. Dover Straits, Panama Canal, Sweden, Prince William Sound, AK), various member entities exhorted IMO to consider the development of a universal tracking system, which in 1998 led to the IMO Marine Safety Committee to formally agree to and adopt Performance Standards for a Universal Shipborne Automatic Identification System (later to be solely known as AIS), which use was mandated in 2000 on all tankers, seagoing passenger and cargo ships (those over 300 GT), via an amendment to the Safety of Life at Sea Convention (SOLAS Regulation V/19.2.4). Since then, AIS carriage requirements have expanded domestically and on smaller vessels; particularly in the United States which requires AIS on all commercial self-propelled vessels of sixty-five feet or greater, most commercial towboats, and any vessel moving certain dangerous cargoes or flammable in bulk.

The IMO (Resolution MSC74(69)) defines the primary functions or purposes of AIS as:

1. in ship-to-ship mode, for collision avoidance;
2. in a ship-to-shore mode, as a tool for vessel traffic management, and,
3. a means to obtain specific data about ships, and their cargo, operating in coastal waters.

AIS devices are designed to operate autonomously, without user intervention or external infrastructure or signals, as transponder require; albeit they can be interrogated (polled) or tele-commanded to report faster or not all). AIS rely upon time-division multiple access (TDMA) procedures. The VHF data link (VDL) is divided into 2,500 equal slots of time per channel to reserve or schedule its transmissions, which it does randomly accessing a free slot, when available. What makes AIS unique to cellular telephones that use TDMA, is that certain AIS devices (i.e. Class A, Class B-SO) self-organize themselves on the VDL. So rather the 'dropping a call' as cell-phone users may experience when they go beyond a cell tower range or when the cell therein is beyond capacity, each AIS acts as its own cell tower and coordinates its reception so to favor AIS transmission that are closest to themselves, and which pose the greater collision risk.

The range of AIS-as with all VHF (line-of-sight) systems-is mostly affected by antenna height; however, since VHF-FM wavelengths are slightly longer than radars, AIS signals tend to cross land and other obstructions moderately well. At sea, an AIS on the water can usually be seen at 3-4 miles, from a lifeboat at 6-8 miles, from fishing boats and pleasure craft at 8-12 miles, and, from large or higher ships at 15-30 miles. Given that its transmissions are line of sight, AIS can also be received from far ashore (25-50 miles out) and from satellite (1,000 miles).

Each IMO required AIS device consists of a: VHF transmitter; three receivers, two dedicated to AIS transmission, and another backwards compatible to VHF DSC (Ch. 70); a VHF and GPS antenna; an internal GPS for timing and positioning; a built in integrity test (BIIT) processor; a minimal keyboard display (MKD); two input-output interfaces, and, at least one output interface.

3019. Classes and Reporting

There are two classes of shipborne AIS transceivers: Class A devices which meet all IMO standards and Class B devices which are intended for non-compulsory use. Each AIS transmission (message) denotes the time of transmission and its source ID; a unique 9-digit Maritime Mobile Station Identity (MMSI) number. In addition, Class A devices transmit the following data, autonomously and continuously every 2-10 seconds (dependent on speed and changing course) and every three minutes when at anchor or moored (if it navigation status has been updated to reflect so), at a power of 12.5 watts:

- Navigation status: underway, anchored, not under command, etc. (manually selected)
- Lat. and long. to 1/10,000 minute
- Course over ground
- Speed over ground Position accuracy; source, i.e. GPS, GLONAS, INS, manually entered, etc.; and, whether Receiver Autonomous Integrity Monitoring (RAIM) is used True heading, to 1/10 degree (via external gyro or transmitting heading device (THD), if connected)
- Rate of turn indication (if connected)

In addition, the Class A AIS will transmit, static and voyage related data, every six minutes:

- IMO number, a unique identifier related to ship's hull
- Radio call sign.
- Name of ship, up to 20 characters
- Type of ship, from predefined list of types
- Dimensions of ship, to nearest meter (derived from the positioning system antenna location)
- Source of positioning system, i.e. GPS, GLONAS, Integrated Navigation System (INS), manually inputted, etc.
- Static Draft, to 0.1 meter; air draft is not defined
- Destination, to 20 characters
- ETA: month, day, hour, and minute in UTC.

There are two variants of Class B AIS devices: Self-Organizing (same as Class A) or Carrier-Sense Mode (only transmit if they 'sense' a free slot is available) devices. Both are interoperable with other AIS devices, but, dissimilar to Class A devices in that they operate at a lower power (Class B-SO @ 5 Watts; Class B0-CS @ 2 Watts) and either every 5-15 seconds (Class B-SO) or at a 30 second fixed reporting rate; and, do not support external sensors (i.e. gyro, rate of turn indicator, etc.); or report their IMO number, destination, static draft, and navigational status; or have the facilities to transmit safety text messages.

Since the advent of the IMO AIS mandate, AIS technology has expanded to other devices such as

- onboard Search and Rescue (SAR) aircraft;
- as shore stations that perform as a network base station;
- co-located on aids to navigation (Real AIS ATON);
- remotely used to transmit ATON information to coincide with an existing physical aid to navigation (Synthetic AIS ATON);
- or where an ATON is electronically charted but does not physically exist (Virtual AIS ATON);
- and, as AIS locating devices, such as AIS EPIRB, AIS Man-overboard devices, and AIS Search and Rescue Transmitter (AIS-SART).

Each unique type of AIS device can be identified by its MMSI format: 111YYYXXX for SAR aircraft AIS; 00YYYXXXX for AIS Base Stations; 99YYYXXXX for AIS ATON; 970YYXXXX for AIS-SART; 9702YXXXX for MOB-AIS; 974YYXXXX for EPIRB-AIS.

AIS locating devices operate differently than most other AIS devices, using 'burst behavior'. To facilitate their locating, these devices transmit a pre-formatted safety text message which states whether the locating device is 'ACTIVE' or under 'TEST'. If the former, they will also transmit 7 position reports per minute, increasing the likelihood that at least one is transmitted on the crest of swell or wave. The great benefit of AIS locating devices is the each transmission includes the device's location, the SAR response unit does not need to continuously hone in or tediously adjust direction finding antennas as is required to locate other beacons or radar transponders; the latter is discussed in the following section.

SEARCH AND RESCUE RADAR TRANSPONDERS/TRANSMITTERS

3020. Operational Characteristics

There are two variants of Search and Rescue Transmitters: one that operates on AIS channels (see Section 3023), and the other that operates as a radar transponder, hereinafter SART. Operating much like a RACON, the **Search and Rescue Radar Transponder (SART)** is a passive rescue device which, when it senses the pulse from a radar operating in the 9 gHz frequency band, emits a series of pulses in response, which alerts the radar operator that some sort of maritime distress is in progress. Further, the SART signal allows the radar operator to home in on the exact location of the SART. The SART can be activated manually, or will activate automatically when placed in water.

The SART signal appears on the radar screen as a series of 12 blips, each 0.64 nautical miles apart. As the vessel or aircraft operating the radar approaches the SART location, the blips change to concentric arcs, and within about a mile of the SART become concentric circles, centered on the SART.

Because the SART actively responds to radar pulses, it also informs its user, with an audible or visual signal, that it is being triggered. This alerts the user in distress that there is an operating radar in the vicinity, whereupon they may send up flares or initiate other actions to indicate their position.

Approved SARTs operate in standby mode for at least 96 hours and actively for at least 8 hours. Because the SART signal is stronger than any surrounding radar returns, it will be easily sensed by any nearby radar. But because it is much weaker than the radar, its own range is the limiting factor in detection.

3021. Factors Affecting SART Range

SART range is affected by three main factors. First, the type of radar and how it is operated is most important. Larger vessels with powerful, high-gain antennae, set higher above sea level, will trigger and detect the SART signal sooner than low-powered radars set closer to sea level. The radar should be set to a range of 12 or 6 miles for best indication of a SARTs signal, and should not have too narrow a receive bandwidth, which might reduce the strength of the received signal.

Second, weather is a factor in SART range. A flat calm might cause multipath propagation and distort the SARTs signal. Heavy seas may cause the SART signal to be received intermittently as the transponder falls into the troughs of the seas. Careful adjustment of the sea and rain clutter controls will maximize the SARTs received signal strength.

Third, the height of the SART will greatly affect the range, because the signal obeys the normal rules for radio waves in its spectrum and does not follow the curvature of the earth, except for a small amount of refraction. Tests indicate that a SART floating in the sea will have a range of about 2 nautical miles when triggered by a radar mounted 15 meters above sea level. At a height of 1 meter, range increases to about 5 miles. To an aircraft actively searching for a SART at an altitude of 3.000 feet, the range increases to about 40 miles.

3022. Operating the Radar for SART Detection

Only an X-band (3 cm) radar can trigger and sense a SART. An S-Band (10 cm) radar will neither trigger nor detect a SART. Normally, an X-band radar will sense a SART at about 8 nm. When triggered by an incoming radar signal, the SART will transmit a return signal across the entire 3 cm radar frequency band. The first signal is a rapid 0.4 microsecond sweep, followed by a 7.5 microsecond sweep, repeated 12 times. This will cause a series of 12 blips on the radar, spaced 0.64 nm apart. See Figure 3022a.

Figure 3022a. SART 12-dot blip code.

For best reception, the radar should be set to medium bandwidth and to the 12 or 6 mile range. Too narrow a bandwidth will cause the SART signal to be weakened, as the radar is not sensing the entire SART pulse. The radar operator's manual should be consulted for these settings. Less expensive radars may not be able to change settings.

As the range to the SART decreases to about 1 nm, the initial 0.4 microsecond sweeps may become visible as weaker and smaller dots on the radar screen. When first sensed, the first blip will appear about 0.6 miles beyond the actual location of the SART. As range decreases, the blips will become centered on the SART.

As the SART is approached more closely, the blips appearing on the radar become concentric arcs centered on the SART itself. The arcs are actually caused by the radar return of side lobes associated with the radar signal. While use of the sea return or clutter control may decrease or eliminate these arcs, it is often best to retain them, as they indicate the proximity of the SART. See Figure 3022b. Eventually the arcs become rings centered on the SART, as in Figure 3022c.

Figure 3022b. SART arcs.

Figure 3022c. SART rings.

On some radars it may be possible to detune the radar signal in situations where heavy clutter or sea return obscures the SART signal. With the Automatic Frequency Control (AFC) on, the SART signal may become more visible, but the radar should be returned to normal operation as soon as possible. The gain control should usually be set to normal level for best detection, with the sea clutter control at its minimum and rain clutter control in normal position for the ambient conditions.

3023. Automatic Identification System - Search and Rescue Transmitter (AIS-SART)

January 1, 2010 the AIS-SART was added to GMDSS regulations as an alternative to the Radar SART. With the approval from IMO SOLAS Amendment in Resolution MSC 256(84) ship owners may choose either Radar SART or AIS SART to be carried on the vessel. AIS-SARTs have a built in GPS and transmit an alert message including the vessel ID and GPS position from the AIS tracking system. This information will appear on an AIS equipped vessel's chart plotter or ECDIS which differs from the traditional SART which displays on the Radar. The much lower operating frequency (160 MHz vs 9000MHz) from the AIS SART significantly increases the range of the signal and because VHF can propagate around land, the signal may be seen "around corners". This is an improvement over Radar SART, particularly in areas of heavily incised coastlines and/or island archipelagos.

3024. Automatic Identification System (AIS) - Aids to Navigation (ATON)

AIS ATON stations broadcast their presence, identity (9-digit Marine Mobile Service Identity (MMSI) number), position, and status at least every three minutes or as needed. These broadcasts can originate from an AIS station located on an existing physical aid to navigation (Real AIS ATON) or from another location (i.e., AIS Base Station). An AIS Base Station signal broadcasted to coincide with an existing physical aid to navigation is known as a Synthetic AIS ATON. An electronically charted, but non-existent as a physical aid to navigation, is identified as a Virtual AIS ATON. The latter two can be used to depict an existing aid to navigation that is off station or not watching properly or to convey an aid to navigation that has yet to be charted. All three variants can be received by any existing AIS mobile device, but they would require an external system for their portrayal (i.e., AIS message 21 capable ECDIS, ECS, radar, PC). How they are portrayed currently varies by manufacturer, but the future intention is for the portrayal to be in accordance with forthcoming International Standards (i.e., IEC 62288 (Ed. 2), IHO S-4 (Ed. 4.4.0)).

Maritime authorities can quickly use Synthetic and Virtual AIS (SAIS/VAIS) ATON, sometime referred to as **eATON,** to temporarily reconstitute port ATON constellations in response to storm or hurricane damage. This grants recovery assets more time to address missing and/or off station aids.

SHIP TRACKING

3025. Long-Range Identification and Tracking (LRIT)

The Long-Range Identification and Tracking (LRIT) system, designated by the International Maritime Organization (IMO), provides for the global identification and tracking of ships. See Figure 3025 for more information.

The obligations of ships to transmit LRIT information and the rights and obligations of SOLAS Contracting Governments and of Search and rescue services to receive LRIT information are established in regulation V/19-1 of the 1974 SOLAS Convention.

The LRIT system consists of the shipborne LRIT information transmitting equipment, the Communication Service Provider(s), the Application Service Provider(s), the LRIT Data Center(s), including any related Vessel Monitoring System(s), the LRIT Data Distribution Plan and the International LRIT Data Exchange. Certain aspects of the performance of the LRIT system are reviewed or audited by the LRIT Coordinator acting on behalf of all SOLAS Contracting Governments.

LRIT information is provided to Contracting Governments to the 1974 SOLAS Convention and Search and rescue services entitled to receive the information, upon request, through a system of National, Regional and Cooperative LRIT Data Centers using the International LRIT Data Exchange.

Each Administration should provide to the LRIT Data Centre it has selected, a list of the ships entitled to fly its flag, which are required to transmit LRIT information, together with other salient details and should update, without undue delay, such lists as and when changes occur. Ships should only transmit the LRIT information to the LRIT Data Centre selected by their Administration.

Additional information concerning LRIT is available at the IMO website via the link in Figure 3025.

Figure 3025. Long-Range Identification and Tracking IMO website.
http://www.imo.org/en/OurWork/Safety/Navigation/Pages/LRIT.aspx

The USCG maintains a National Data Center (NDC). The NDC monitors IMO member state ships that are 300 gross tons or greater on international voyages and either bound for a U.S.port or traveling within 1000 nm of the U.S. coast. LRIT complements existing classified and unclassified systems to improve Maritime Domain Awareness.

LRIT is a satellite-based, real-time reporting mechanism that allows unique visibility to position reports of vessels that would otherwise be invisible and potentially a threat to the United States.

The user interface for the US NDC is located at the Navigation Center (NAVCEN) in Alexandria, Virginia.

NAVCEN operates the US LRIT interface called the Business Help Desk (BHD). BHD operators can perform a multitude of operations with a web-based user interface. Within this web-based application, the BHD watchstanders can view and request vessel status, see vessel information, request vessel positions, and increase and decrease vessel reporting rates.

The US NDC stores all of the positions from any LRIT ship, foreign or domestic, that enters our coastal water polygons. This information is available in real time to the BHD watchstander after performing a basic search for a vessel using the vessel name, IMO number, or MMSI (Maritime Mobile Service Identity) number. Per the LRIT international guidelines, the default ship reporting rate is every six hours. However, functionality is built in to allow end users to request a onetime poll that gives an on-demand current position. Watchstanders can also increase the reporting rate to every 3 hours, 1 hour, 30 minutes, or 15 minutes for a specified period of time.

3026. Commercial Ship Tracking

AIS data is viewable publicly, on the internet, without the need for an AIS receiver. Global AIS transceiver data collected from both satellite and internet-connected shore-based stations are aggregated and made available on the internet through a number of service providers. Data aggregated this way can be viewed on any internet-capable device to provide near global, real-time position data from anywhere in the world. Typical data includes vessel name, details, location, speed and heading on a map, is searchable, has potentially unlimited, global range and the history is archived. Most of this data is free of charge but satellite data and special services such as searching the archives are usually supplied at a cost. The data is a read-only view and the users will not be seen on the AIS network itself.

Figure 3026a. http:// www.shipfinder.com

For an example of a commercial ship tracking website, providing AIS data on merchant vessels to the public, follow the link in Figure 3026a. Figure 3026b depicts a moment in time for ships transiting the Indian Ocean while transmitted AIS data.

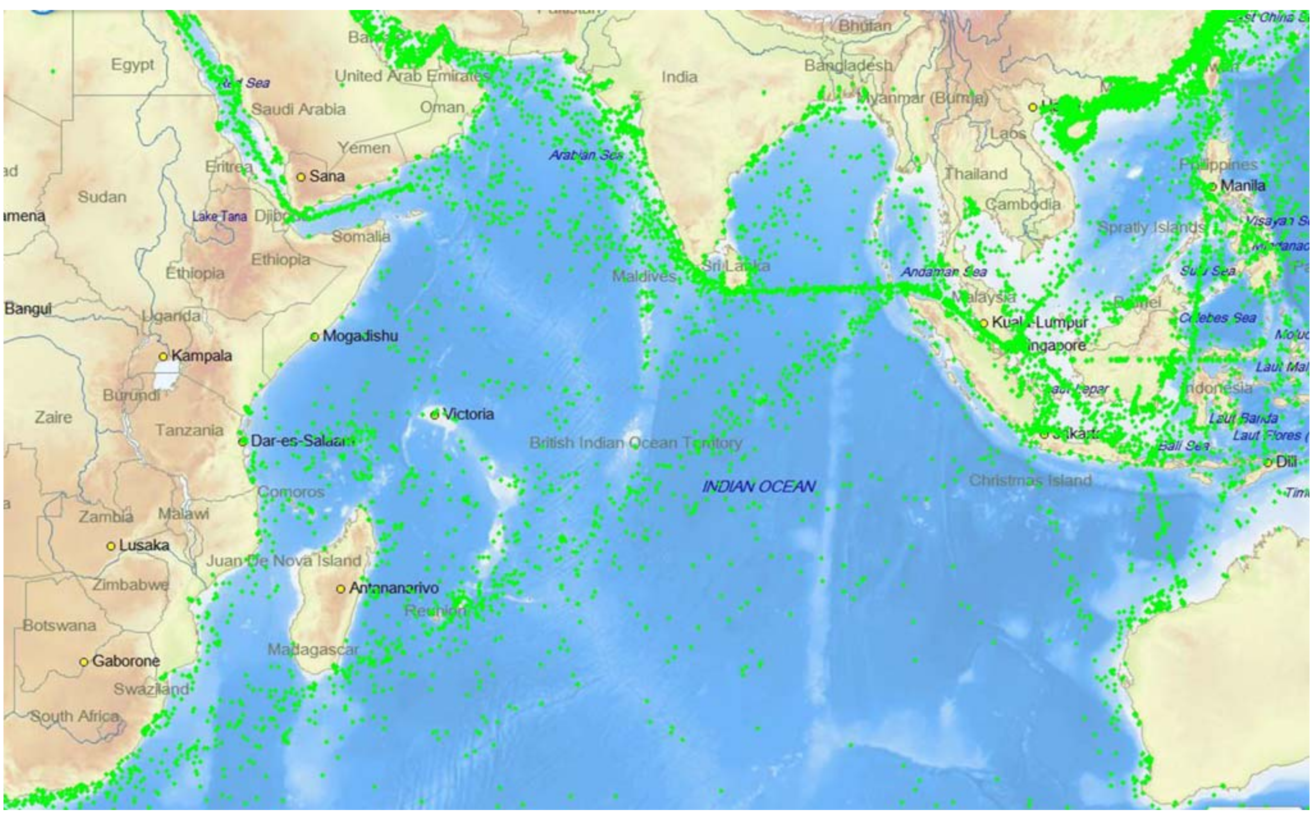

Figure 3026b. Typical AIS ship data for Indian Ocean.

U.S. MARITIME ADVISORY SYSTEM - GLOBAL

3027. Alerts and Advisories

In late 2016, MARAD launched the new U.S. Maritime Advisory System, which represents the most significant update since 1939 to the U.S. government process for issuing maritime security alerts and advisories. The new system establishes a single federal process to expeditiously provide maritime threat information to maritime industry stakeholders including vessels at sea. In response to valuable feedback from stakeholders, the **Maritime Advisory System** was developed to streamline, consolidate, and replace maritime threat information previously disseminated in three separate government agency instruments: Special Warnings, MARAD Advisories, and global maritime security related Marine Safety Information Bulletins.

The U.S. Maritime Advisory System includes two types of notifications: A **U.S. Maritime Alert** and a **U.S. Maritime Advisory**. Maritime Alerts quickly provide basic threat information to the maritime industry. When amplifying information is available, a more detailed U.S. Maritime Advisory may be issued on a threat and could include recommendations and identify available resources. U.S. Maritime Alerts and U.S. Maritime Advisories will be broadcast by the National Geospatial-Intelligence Agency, emailed to maritime industry stakeholders, and posted to the Maritime Security Communications with Industry (MSCI) web portal. A link to the web portal is provided in Figure 3027.

The U.S. Maritime Advisory System is a whole-of-government notification mechanism. The Departments of State, Defense, Justice, Transportation, and Homeland Security, and the intelligence community, supported the development of this new system in coordination with representatives from the U.S. maritime industry through the Alerts, Warnings and Notifications Working Group.

Questions regarding the U.S. Maritime Advisory System may be emailed to MARADSecurity@dot.gov. Additional contact information is available on the MSCI web portal.

Figure 3027. MARAD's Maritime Security Communications with Industry website. http://www.marad.dot.gov/MSCI

CHAPTER 31

REPORTING

NAVIGATIONAL AND OCEANOGRAPHIC REPORTS

3100. Opportunity to Contribute

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 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.

3101. Responsibility for Information

The National Geospatial-Intelligence Agency (NGA), the U.S. Naval Oceanographic Office (NAVOCEANO), the U.S. Coast Guard (USCG) and the National Oceanic and Atmospheric Administration (NOAA) are the primary agencies which receive, process, and disseminate marine information in the U.S.

NGA 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.

NOAA 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 NGA, NOAA, 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. NGA and NOAA 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 NGA, NOAA and USCG 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.

SAFETY REPORTS

3102. 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 section include ice, floating derelicts, wrecks, shoals, volcanic activity, mines, and other hazards to shipping.

1. Ice—The North American Ice Service (NAIS), a partnership comprised of the International Ice Patrol (IIP), the Canadian Ice Service (CIS), and the U.S. National Ice Center (NIC), provides year-round maritime safety information on iceberg and sea ice conditions in the vicinity of the Grand Banks of Newfoundland and the east coast of Labrador, Canada.

When mariners encounter ice, icebergs, bergy bits, or growlers in the North Atlantic, concentration, thickness, and the position of leading edge should be reported to Commander, International Ice Patrol, New London, CT through a U.S. Coast Guard communications station.

Satellite telephone calls may be made to the International Ice Patrol Operations Center throughout the season at +1 860 271 2626 (toll free 877 423 7287, fax: 860 271 2773, email: iipcomms@uscg.mil).

Figure 3102a. International Ice Patrol.
http://www.navcen.uscg.gov/IIP.

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.

For more detailed information on ice reporting consult *Pub No. 117 Radio Navigation Aids,* under Chapter 3 - Radio Navigational Warnings (section 300I: and section 300J: International Ice Warnings). See Figure 3102b for link.

Figure 3102b. NGA- Radio Navigational Aids (Pub. No. 117).
https://msi.nga.mil/NGAPortal/MSI.portal?_nfpb=true&_st=&_pageLabel=msi_portal_page_62&pubCode=0009

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 NGA's Maritime Safety Watch via 1-800-362-6289 or navsafety@nga.mil. An uncharted depth of 300 fathoms or less is considered an urgent danger to submarine navigation. Immediately upon receipt of any information reporting dangers to navigation, NGA may issue an appropriate navigation safety 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 NGA at the earliest opportunity. Clear and properly annotated echograms and navigation logs are especially important in verifying or disproving shoal reports.

5. Discolored Water—Discolored water is an area of seawater having a color distinctly different from the surrounding water. These observations will normally be of seawater having a color other than the blues and greens typically seen. Variations of the colors – including red, yellow, green and brown, as well as black and white – have been reported. This may be due to dumping (pollution), the existence of shoals, or underwater features such as submerged volcanoes. In near-shore areas, discoloration often results from disturbance of sediment, e.g., disturbances by propeller wash. Discolorations may appear in patches, streaks, or large areas and may be caused by concentrations of inorganic or organic particles or plankton.

In normally deep waters, discolored water can be a strong indication of undersea growth of coral reefs, submerged volcanoes, seamounts, pinnacles and the like. As these features grow in size and dimension, their only indication may be in the form of discolored water on the surface of the sea. Mariners must be prudent in such waters, as they will normally be in areas that are not well surveyed and outside of established routes for oceangoing vessels.

NGA does not maintain a database of such occurrences worldwide. In areas of active submerged volcanoes, discolored water is a common occurrence and all such reports are charted or included in a *Notice to Mariners* correction. Mariners are urged to submit new reports of discolored water to the nearest NAVAREA Coordinator via coast radio stations (for NAVAREA IV and NAVAREA XII) by e-mail to navsafety@nga.mil. Reports can also be submitted via the NGA Maritime Safety Information Web site (https://msi.nga.mil).

The legend "discolored water" appears on many NGA charts, particularly those of the Pacific Ocean where underwater volcanic action is known to occur. In such areas, shoal water or discolored water may suddenly appear where only deep water has been historically depicted. Most of these legends remain on the charts from the last century, when very few deep sea soundings were available and less was known about the causes of discolored water. Few reports of discolored water have proved on examination to be caused by shoals. Nonetheless, due to the isolated areas normally in question, mariners should always give prudent respect to what may lie beneath the surface.

Today, such reports can be compared with the accumulated information for the area concerned. A more thorough assessment can be made using imagery if the water conditions and depth (roughly less than 100 feet) allow.

Mariners are therefore encouraged, while having due regard to the safety of their vessels, to approach sightings and areas of discolored water to find whether or not the discoloration is due to shoaling. If there is good reason to suppose the discoloration is due to shoal water, a report should be made as noted above.

Volcanic Activity. On occasion, volcanic eruptions may occur beneath the surface of the water. These submarine eruptions may occur more frequently and may 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 (see Figure 3102c). Mariners witnessing submarine volcanic activity have reported trails of steam with a foul sulfurous odor rising from the sea surface and unusual 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 cooler 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 constitute a hazardous shoal in only a few years.

Figure 3102c. USS Bainbridge stopped near a pumice raft in the Red Sea.

Variations in Color. The normal color of the sea in the open ocean in middle and low latitudes is an intense blue or ultramarine. The following variations in appearance occur elsewhere:

- In coastal regions and in the open sea at higher latitudes, where the minute floating animal and vegetable life of the sea (plankton) is in greater abundance, the blue of the sea is modified to shades of green and bluish-green. This discoloration results from a soluble yellow pigment discharged by the plant constituents of the plankton.
- When plankton is found in dense concentrations, the color of the organisms themselves may discolor the sea, giving it a more or less intense brown or red color. The Red Sea, Gulf of California, the region of the Peru Current, South African waters, and the Malabar Coast of India are particularly liable to this variation, seasonally.

- Plankton is sometimes exterminated suddenly by changes in sea conditions, producing a dirty brown or grayish-brown discoloration. This occurs on an unusually extensive scale at times off the Peruvian coast, where the phenomenon is called “Aguaje.”
- Larger masses of animate matter, such as fish spawn or floating kelp may produce other kinds of temporary discoloration.
- Mud carried down by rivers produces discoloration which, in the case of the great rivers, may affect a large sea area, such as the Amazon River outfall. Soil or sand particles may be carried out to sea by wind or dust storms, and volcanic dust may fall over a sea area. In all such cases, the water is more or less muddy in appearance.
- Submarine earthquakes may also produce mud or sand discoloration in relatively shallow water, and crude oil has sometimes been seen to gush up. The sea may be extensively covered with floating pumice after a volcanic eruption.
- Isolated shoals in deep water may make the water appear discolored, the color varying with the depth of the water. The play of the sun and cloud on the sea may often produce patches appearing at a distance convincingly like shoal water.

Visibility. The distance at which coral reefs can be seen is dependent upon the observer’s height-of-eye, the state of the sea, and the relative position of the sun. When the sea is glassy calm, it is extremely difficult to distinguish the color difference between shallow and deep water. The best conditions for sighting reefs result from a relatively high position, with the sun above 20 degrees elevation and behind the observer, and a sea ruffled by a slight breeze. Under these conditions, with a height of eye of 10-15 meters it is usually possible to sight patches at a depth of less than 6-8 meters from a distance of a few hundred yards.

The use of polarized lenses is strongly recommended, as they make the variations in color of the water stand out more clearly.

If the water is clear, patches with depths of less than 1 meter will appear to be light brown in color; those with depths of 2 meters or more appear to be light green, deepening to a darker green for depths of about 6 meters, and finally to a deep blue for depths over 25 meters. Cloud shadows and shoals of fish may be quite indistinguishable from reefs, but it may be possible to identify them by their movement.

The edges of coral reefs are usually more uniform on their windward or exposed sides and are therefore more easily seen, while the leeward sides are frequently characterized by detached coral heads that are more difficult to see clearly. Water over submerged coral reefs is normally a light blue.

Due to the uncertainty of what discolored water may indicate, mariners are always urged to exercise extreme caution when in its vicinity. New reports of discolored water should be reported immediately with resulting chart, publication and radio/satellite warnings issued as appropriate.

6. **Mines—**All mines or objects resembling mines should be considered armed and dangerous. An immediate radio report to NGA 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

3103. 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? Universal Time (UT) 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—NGA NAVSAFETY SPRINGFIELD VA

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 NGA *Pub. 117, Radio Navigational Aids* (see Figure 3102b for link).

SOUNDING REPORTS

3104. Sounding Reports

Acquisition of reliable sounding data from all ocean areas of the world is a continuing effort of NGA, NAVOCEANO, and NOAA. 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.

3105. 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”

3106. Fix Accuracy

A realistic goal of open ocean positioning for sounding reports is a few meters using GPS. 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 NGA NAVSAFETY SPRINGFIELD VA, giving the best available positioning accuracy. Echograms and other supporting information should then be forwarded by mail to NGA: Maritime Safety Office, Mail Stop N64-SFH, National Geospatial-Intelligence Agency, 7500 Geoint Dr., Springfield, VA 22150-7500.

The accuracy goal noted above has been established to enable NGA 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 be identified.

3107. 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 NGA.

3108. 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.

3109. 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 NGA 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 UT, 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—**Universal Time (UT) 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 3109a and Figure 3109b 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 NGA, 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:

MARITIME SAFETY OFFICE
MAIL STOP N64-SFH
NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY
7500 GEOINT DRIVE
SPRINGFIELD, VA 22150-7500
(or email: navsafety@nga.mil)

MARINE DATA REPORTS

3110. Marine Information Reports

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

1. Discrepancies in published information

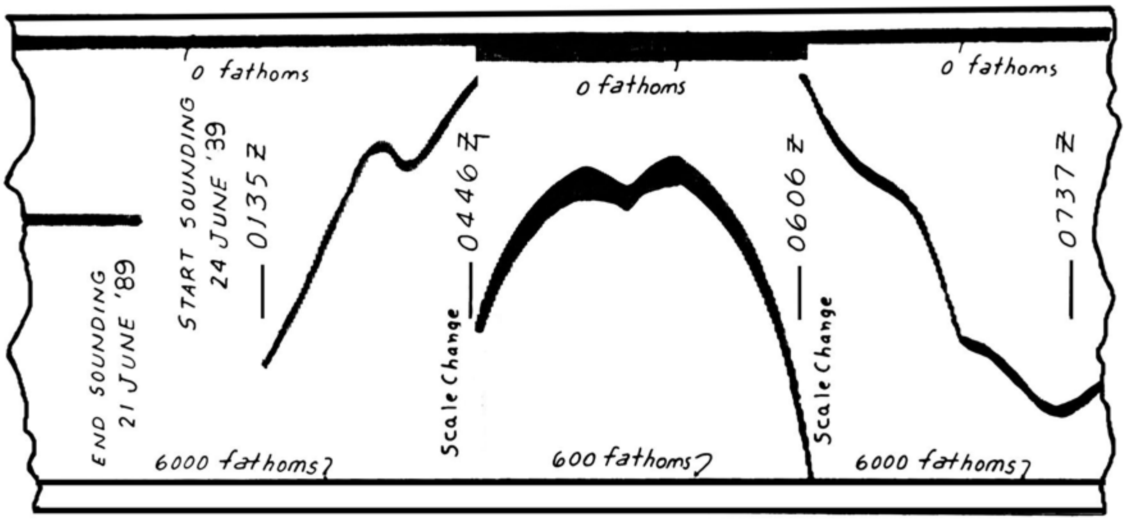

Figure 3109a. Annotated echo sounding record.

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 3109b. Typical navigation log for hydrographic reporting.

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 NGA 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 provided or posted on the internet by NGA or NOAA. It may be more convenient to annotate information (such as uncharted or erroneously charted shoals, buildings, or geological features) directly on the affected chart and send it to NGA. Appropriate supporting information should also be provided. NGA forwards reports as necessary to NOAA, 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.

A Marine Information Report and Suggestion Sheet template, along with instructions, is found in each weekly *US Notice to Mariners*.

3111. Electronic Navigation System Reports

Reports on electronic navigation anomalies or any unusual reception while using the electronic navigation systems 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

3112. 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

3113. Magnetic Disturbances

Magnetic anomalies, the result of a variety of causes, exist in many parts of the world. NGA 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 NGA.

PORT INFORMATION REPORTS

3114. 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.

Reports regarding U.S. waters and the U.S. Coast Pilot may be submitted through the NOAA Nautical Inquiry and Comment System link provided in Figure 3114.

Figure 3114. Link to NOAA Nautical Inquiry and Comment System. https://ocsdata.ncd.noaa.gov/idrs/inquiry.aspx

In some cases it may be more convenient and more effective to annotate information directly on a chart and mail it to NGA. 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 NGA by including NGA Maritime Safety Office, Springfield, VA as an INFO addressee on messages containing hydrographic information.

3115. 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. Digital images, particularly a series of overlapping views showing the coastline, landmarks, and harbor entrances are very useful.

When taking images for inclusion in NGA nautical publication, please use the highest resolution possible and send the image(s) with description of the feature and the exact Lat./Long. where the image was taken to: navsafety@nga.mil or to NOAA, for U.S. waters, through the link found in Figure 3114. There is also a desire for video of actual approaches to entrances to ports and harbors. See additional discussion on this topic below under "Images."

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, 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 NGA, NOAA, or U.S. 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*?

Images

Images of features or aids to navigation described in nautical publication are desirable. These may include annotations by the photographer. Additional information (or metadata) should accompany images sent to NGA, to include the camera position by bearing and distance from a charted object (or feature) 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. Bearings and distances (from the vessel) of uncharted features identified in the image should be included. Images may be sent electronically via e-mail or transfered to CD/DVD's and sent via snail mail if file sizes warrant.

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 NGA or to NOAA for U.S. waters through the NOAA Nautical Inquiry and Comments System via the link found in Figure 3114. It is not essential that port information 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

3116. 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.

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.

3117. Route Reports

Route Reports enable NGA, 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?

AMVER

3118. The Automated Mutual-Assistance Vessel Rescue System (AMVER)

The purpose of ship reporting systems is to monitor vessels' positions at sea so that a response to any high-seas emergency can be coordinated among those nearest and best able to help. It is important that complete information be made available to search and rescue (SAR) coordinators immediately so that the right type of assistance can be sent to the scene with the least possible delay.

Figure 3118. AMVER burgee.

For example, a medical emergency at sea might require a doctor; a ship reporting system can find the nearest vessel with a doctor aboard. A sinking craft might require a vessel to rescue the crew, and perhaps another to provide a lee. A ship reporting system allows SAR coordinators to quickly assemble the required assets to complete the rescue.

The International Convention for the Safety of Life at Sea (SOLAS) obligates the master of any vessel who becomes aware of a distress incident to proceed to the emergency and assist until other aid is at hand or until released by the distressed vessel. Other international treaties and conventions impose the same requirement.

By maintaining a database of information as to the particulars of each participating vessel, and monitoring their positions as their voyages proceed, the AMVER coordinator can quickly ascertain which vessels are closest and best able to respond to any maritime distress incident. They can also release vessels that might feel obligated to respond from their legal obligation to do so, allowing them to proceed on their way without incurring liability for not responding. International agreements ensure that no costs are incurred by a participating vessel.

Several ship reporting systems are in operation throughout the world. The particulars of each system are given in publications of the International Maritime Organization (IMO). Masters of vessels making offshore passages are requested to always participate these systems when in the areas covered by them. The only worldwide system in operation is the U.S. Coast Guard's AMVER system.

AMVER is an international maritime mutual assistance program that coordinates search and rescue efforts around the world. It is voluntary, free of charge, and endorsed by the International Maritime Organization (IMO). Merchant ships of all nations are encouraged to file a sailing plan, periodic position reports, and a final report at the end of each voyage, to the AMVER Center located in the U.S. Coast Guard Operations Systems Center in Martinsburg, WV. Reports can be sent via e-mail, Inmarsat-C, AMVER/SEAS "compressed message" format, Sat-C format, HF radiotelex, HF radio or telefax message. Most reports can be sent at little or no cost to the ship.

Data from these reports is protected as "commercial proprietary" business information, and is released by U.S. Coast Guard only to recognized national SAR authorities and only for the purposes of SAR in an actual distress. Information concerning the predicted location and SAR characteristics of each vessel is available upon request to recognized SAR agencies of any nation or to vessels needing assistance. Predicted locations are disclosed only for reasons related to marine safety.

The AMVER computer uses a dead reckoning system to predict the positions of participating ships at any time during their voyage. Benefits to participating vessels and companies include:

- Improved chances of timely assistance in an emergency.
- Reduced number of calls for ships not favorably located.
- Reduced lost time for vessels responding.
- Added safety for crews in the event of an overdue vessel.

AMVER participants can also act as the eyes and ears of SAR authorities to verify the authenticity of reports, reducing the strain on SAR personnel and facilities. AMVER is designed to compliment computer and communications technologies, including the Global Maritime Distress Safety System (GMDSS) that provides distress alerting and GPS positioning systems. These technologies can reduce or entirely eliminate the search aspect of search and rescue (since the precise location of the distress can be known), allowing SAR authorities to concentrate immediately on the response.

The AMVER Sailing Plan provides information on the port of departure, destination, course, speed, navigational method, waypoints, communications capabilities, and the presence of onboard medical personnel. The database contains information on the ship's official name and registry, call sign, type of ship, tonnage, propulsion, maximum speed, and ownership. Changes in any of this data should be reported to AMVER at the earliest opportunity.

AMVER participants bound for U.S. ports enjoy an additional benefit: AMVER messages which include the necessary information are considered to meet the requirements of 33 CFR 161 (Notice of Arrival).

3119. The AMVER Communications Network

The following methods are recommended for ships to transmit information to AMVER:

1. **Electronic mail** (e-mail) via the Internet: The AMVER internet e-mail address is amvermsg@amver.com. If a ship already has an inexpensive means of sending e-mail to an internet address, this is the preferred method. The land-based portion of an e-mail message is free, but there may be a charge for any ship-to-shore portion. Reports should be sent in the body of the message, not as attachments.

2. **AMVER/SEAS Compressed Message via Inmarsat-C via Telenor**. AMVER address: National Oceanic and Atmospheric Administration (NOAA) Phone number entered in the ADDRESSBOOK. [For information, please see the instruction sheet for your brand of International Mobile Satellite Organization (INMARSAT)-C transceiver.]

- Ships must be equipped with INMARSAT Standard C transceiver with floppy drive and capability to transmit a binary file [ship's GMDSS INMARSAT-C transceiver can be used].
- Ships must have an IBM-compatible computer (which is not part of the ship's GMDSS system), and it must meet the following minimum requirements:

— hard drive
— 286 MHz or better processor
— VGA graphics
— an interface between the computer and the INMARSAT transceiver
— AMVER/SEAS software - free via NOAA at http://www.aoml.noaa.gov/phod/goos/seas/amverseas_software.php

Ships that meet the system requirements may send combined AMVER/Weather observation messages *Free of Charge* via Telenor Land Earth Stations at:

001 Atlantic Ocean Region-West (AOR-W)-Southbury
101 Atlantic Ocean Region East (AOR-E)-Southbury
201 Pacific Ocean Region (POR)-Santa Paula
321 Indian Ocean Region (IOR)-Assaguel

3. **HF Radiotelex Service** - As March 31, 2012 the Coast Guard discontinued all ship/Shore/ship SITOR services except for marine information broadcasts.

4. **HF Radio** at no cost via Coast Guard contractual agreements with the following companies:

- Mobile Marine Radio (WLO)
- Mobile (WCL)
- Marina Del Rey (KNN)
- Seattle (KLB)

5. **Telex**: AMVER Address (0) (230) 127594 AMVERNYK.

AMVER reports may be filed via telex using either satellite (code 43) or HF radio. Ships must pay the tariffs for satellite communications. Telex is a preferred method when less costly methods are not available.

6. **Telefax**: Telefacsimile (telefax) phone number to the USCG Operations Systems Center (OSC) in Martinsburg, West Virginia: (01) (304) 264-2505.

In the event other communication media are unavailable or inaccessible, AMVER reports may be faxed directly to the AMVER computer center. However, this is the least desirable method of communication since it involves manual input of information to the computer verses electronic processing. Please Note: Do not fax reports to the AMVER Maritime Relations Office (AMR) in New York since it is not staffed 24 hours a day, seven days a week, and relay and processing of reports is delayed pending normal Monday-Friday business hours.

3120. AMVER Participation

Instructions guiding participation in the AMVER System are available online from the **AMVER website**. The AMVER User's Manual is published in Chinese, Dutch, and English. This manual is available online (at no cost) via the website and link provided in Figure 3120.

Figure 3120. AMVER Ship Reporting System Manual.
http://www.amver.com

To enroll in AMVER, a ship must first complete a SAR Questionnaire (SAR-Q). Participation involves filing four types of reports:

1. Sailing Plan
2. Position Report
3. Deviation Report
4. Final Report

The **Sailing Plan** is sent before leaving port, and indicates the departure time and date, destination, route and waypoints, speed, and navigational method.

The **Position Report** is sent after the first 24 hours to confirm departure as planned and conformance with the reported Sailing Plan. An additional report is requested every 48 hours to verify the DR plot being kept in the AMVER computer.

A **Deviation Report** should be sent whenever a change of route is made, or a change to course or speed due to weather, heavy seas, casualty, or any other action that would render the computerized DR inaccurate.

A **Final Report** should be sent at the destination port. The system then removes the vessel from the DR plot and logs the total time the ship was participating.

Vessels that travel certain routes on a recurring basis may be automatically tracked for successive voyages as long as delays in regular departures are reported. The system may also be used to track vessels sailing under special circumstances such as tall ships, large ocean tows, research vessel operations, factory fishing vessels, etc. At any given time nearly 3,000 vessels worldwide are being plotted by AMVER, and the number of persons rescued as a direct result of AMVER operations is in the hundreds each year.

3121. SAR Manuals

SAR operational procedures are contained in the International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual, a three volume set published jointly by the IMO and the ICAO. Volume III of this manual is required aboard SOLAS vessels.

The **United States National Search and Rescue Supplement (NSS)** to the IAMSAR manual provides guidance to all federal forces, military and civilian, that support civil search and rescue operations. The NSS is available online via the link from provided in Figure 3121.

Figure 3121. U.S. National Search and Rescue Supplement to the IAMSAR.
https://community.apan.org/wg/jtf-sar/m/mediagallery/162963

3122. AMVER Reporting Requirements

The U.S. Maritime Administration (MARAD) regulations state that certain U.S. flag vessels and foreign flag "War Risk" vessels must report and regularly update their voyages to the AMVER Center. This reporting is required of the following: (a) U.S. flag vessels of 1,000 tons or greater, operating in foreign commerce; (b) foreign flag vessels of 1,000 gross tons or greater, for which an Interim War Risk Insurance Binder has been issued under the provisions of Title XII, Merchant Marine Act, 1936.

3123. The Surface Picture (SURPIC)

When a maritime distress is reported to SAR authorities, the AMVER computer is queried to produce a **Surface Picture (SURPIC)** in the vicinity of the distress. Several different types of SURPIC are available, and they can be generated for any specified time. The SURPIC output is a text file containing the names of all vessels meeting the criteria requested, plus a subset of the information recorded in the database about each vessel. See Figure 3123. A graphic display can be brought up for the **Rescue Coordination Center (RCC)** to use, and the data can be sent immediately to other SAR authorities worldwide. The information provided by the SURPIC includes the position of all vessels in the requested area, their courses, speeds, estimated time to reach the scene of the distress, and the amount of deviation from its course required for each vessel if it were to divert. RCC staff can then direct the best-placed, best-equipped vessel to respond.

Four types of SURPIC can be generated:

A **Radius SURPIC** may be requested for any radius from 50 to 500 miles. A sample request might read:

"REQUEST 062100Z RADIUS SURPIC OF DOCTOR-SHIPS WITHIN 800 MILES OF 43.6N 030.2W FOR MEDICAL EVALUATION M/V SEVEN SEAS."

The **Rectangular SURPIC** is obtained by specifying the date, time, and two latitudes and two longitudes. As with the Radius SURPIC, the controller can limit the types of ships to be listed. There is no maximum or minimum size limitation on a Rectangular SURPIC.

A sample Area SURPIC request is as follows:

"REQUEST 151300Z AREA SURPIC OF WEST-BOUND SHIPS FROM 43N TO 31N LATITUDE AND FROM 130W TO 150W LONGITUDE FOR SHIP DISTRESS M/V EVENING SUN LOCATION 37N, 140W."

The **Snapshot** or **Trackline SURPIC** is obtained by specifying the date and time, two points (P1 and P2), whether the trackline should be rhumb line or great circle, what the half-width (D) coverage should be (in nautical miles), and whether all ships are desired or only those meeting certain parameters (e.g. doctor on board).

Name	*Call sign*	*Position*	*Course*	*Speed*	*SAR data*	*Destination and ETA*	
CHILE MARU CPA 258 DEG. 012 MI. 032000Z	JAYU	26.2 N 179.9E	C294	12.5K	H 1 6 R T X Z	KOBE	11
WILYAMA CPA 152 DEG. 092 MI. 032000Z	LKBD	24.8N 179.1W	C106	14.0K	H X R T V X Z	BALBOA	21
PRES CLEVELAND CPA 265 WILL PASS WITHIN 10 MI. 040430Z	WITM	25.5N 177.0W	C284	19.3K	H 2 4 R D T X Z S	YKHAMA	08
AENEAS CPA 265 DEG. 175 MI. 03200Z	GMRT	25.9N 176.9E	C285	16.0K	H 8 R N V X Z	YKHAMA	10

Figure 3123. Radius SURPIC as received by a rescue center.

A Snapshot Trackline SURPIC request might look like:

"REQUEST 310100Z GREAT CIRCLE TRACKLINE SURPIC OF ALL SHIPS WITHIN 50 MILES OF A LINE FROM 20.1N 150.2W TO 21.5N 158.0W FOR AIRCRAFT PRECAUTION."

A **Moving Point SURPIC** is defined by the starting and ending points of a vessel's trackline, the estimated departure time of the vessel, and the varying time of the SURPIC. This SURPIC is useful when a vessel is overdue at her destination. If the vessel's trackline can be accurately estimated, a SURPIC can generated for increments of time along the trackline, and a list can be generated of ships that might have sighted the missing ship.

3124. Uses of AMVER Information

After evaluating the circumstances of a reported distress, The RCC can select the best available vessel to divert to the scene. In many cases a participating ship will be asked only to change course for a few hours or take a slightly different route to their destination, in order to provide a lookout in a certain area. RCC coordinators strive to use participating ships efficiently, and release them as soon as possible.

An example of the use of a Radius SURPIC is depicted in Figure 3124. In this situation rescue authorities believe that a ship in distress, or her survivors, might be found in the rectangular area. The RCC requests a SURPIC of all eastbound ships within 100 miles of a position well west of the rectangular area. With this list, the RCC staff prepares a modified route for each of four ships which will comprise a "search team" to cover the entire area, while adding only a few miles to each ship's route. Messages to each ship specify the exact route to follow and what to look for enroute.

Each ship contacted may be asked to sail a rhumb line between two specified points, one at the beginning of the search area and one at the end. By carefully assigning ships to areas of needed coverage, very little time need be lost from the sailing schedule of each cooperating ship. Those ships joining the search would report their positions every few hours to the RCC, together with weather data and any significant sightings. In order to achieve saturation coverage, a westbound SURPIC at the eastern end of the search area would also be used.

The Trackline SURPIC is most commonly used as a precautionary measure for aircraft. Occasionally a plane loses one or more of its engines. A Trackline SURPIC, provided from the point of difficulty to the destination, provides the pilot with the added assurance of 1) knowing positions of vessels beneath him/her and 2) that these ships were alerted. While the chance of an airliner experiencing such an emergency is extremely remote, SURPICs have been used successfully to save the lives of pilots of general aviation aircraft on oceanic flights.

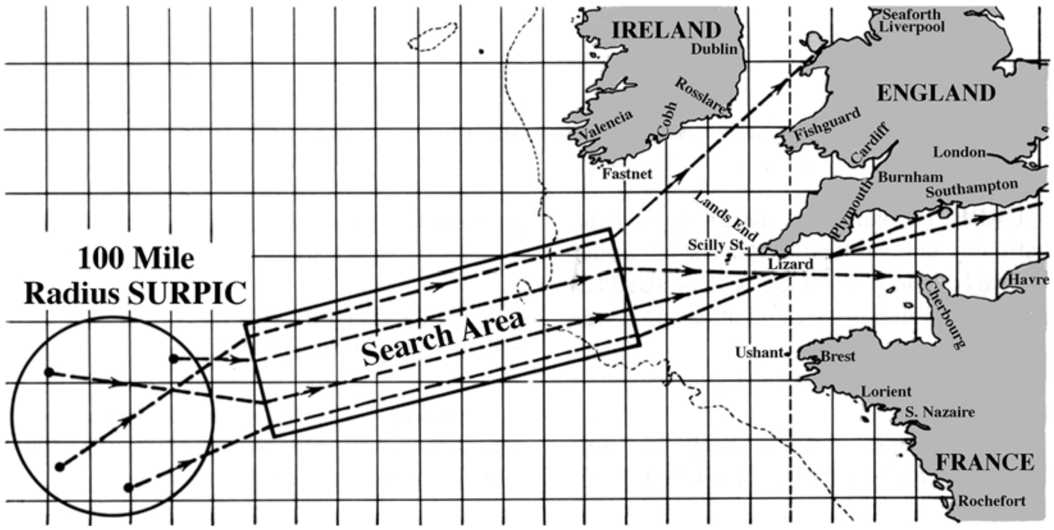

Figure 3124. Example of the use of a radius SURPIC to locate ships to search a rectangular area.