UNREP, an entire fleet can be resupplied, rearmed, and refueled within hours, while it is proceeding on its mission.

Some ships—such as replenishment tankers (AOR), oilers (AO), fast combat support ships (AOE), combat store ships (AFS), and ammunition ships (AE)—spend a great deal of their time conducting UNREPs. Other ships conduct UNREPs as necessary to keep themselves ready and on station. An aircraft carrier, for example, must UNREP with an ammunition ship to receive ordnance if it has been conducting strike operations and might conduct periodic UNREPs with its accompanying destroyers to replenish their expended fuel.

Different types of rigs are used for different purposes. In the discussion that follows, some of the more typical rigs will be described. For more detailed information, consult the naval warfare publication entitled *Replenishment at Sea* (NWP-14).

Cargo Rigs

Various combinations of winches, blocks, and booms have been found to be effective in passing cargo (such as ammunition, groceries, or spare parts) from one ship to another while they are both underway.

Burton rig. Cargo is moved from the delivering ship to the receiving ship by two burton whips, which correspond to the hatch whip

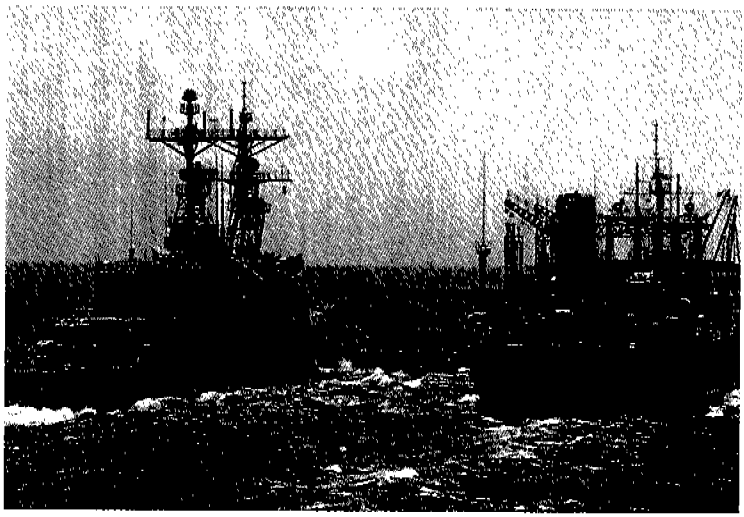

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Figure 19.16. Underway replenishment (UNREP) keeps ships on station for long periods of time.

and cargo whip in a *yard and stay rig* used alongside a pier. Winches on each ship handle the two whips involved. The delivering ship hoists the load clear, then the receiving ship takes in her burton whip as the delivering ship slacks hers off. When the load is spotted over the deck of the receiving ship, her whip is slacked and the load is eased to the deck. The entire operation requires skillful coordination between the two winchmen. They must keep constant tension on both whips at all times, whether they are running in or out, and they must keep the load just clear of the water. If the load is too high, the strain on all rigging is greatly increased. If the load is allowed to drop too low, it may be swept away by the passing sea. The maximum load that can be handled by this rig is 3500 pounds.

Housefall rig. In this method, both cargo whips are handled by the delivering ship. The whip that moves cargo to the receiving ship is called the outboard transfer whip (same as yard whip), and the whip that hauls the cargo hook back to the delivering ship is called the inboard transfer whip (same as cargo whip). Both winchmen are on the delivering ship. The maximum load is 2500 pounds.

Double housefall rig. This rig is used to speed transfers to ships that cannot handle more than one housefall rig. It is slower than housefalling to two separate receiving stations, but faster than housefalling to one station. In this method, the delivering ship uses two

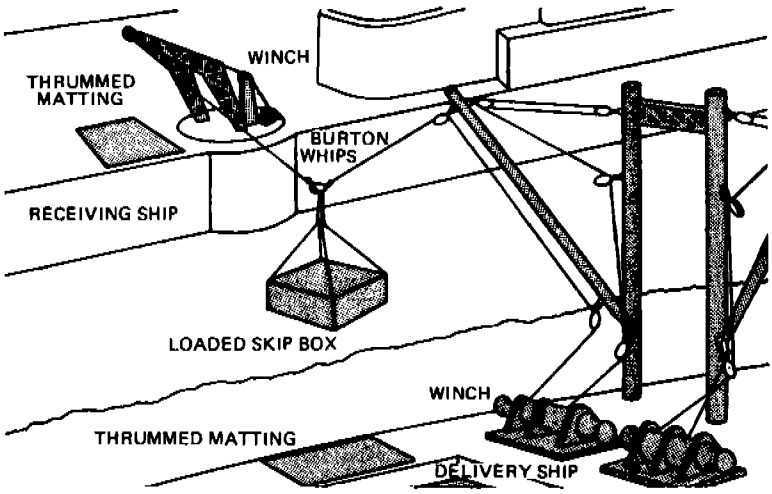

Figure 19.17. The Burton rig is similar to the yard-and-stay rig used alongside a pier.

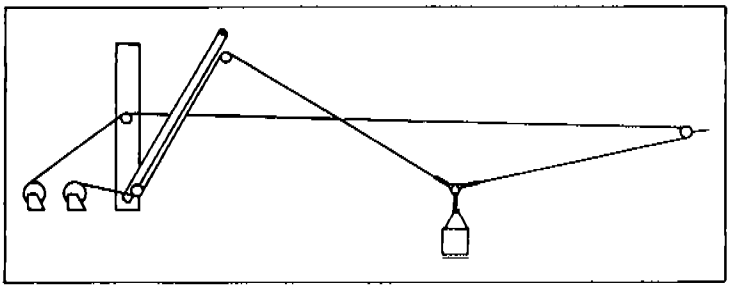

Figure 19.18. A basic housefall rig.

adjacent housefall rigs attached to a single point on the receiving ship. In handling cargo with this method, the delivering ship sends over a loaded net with one rig at the same time the other brings back an empty net from the receiving ship. The two nets pass each other in opposite directions each time a load is transferred.

Wire highline rig. This method involves a trolley moving on a highline that is attached to the receiving ship and kept taut by a winch on the delivering ship. An outhaul line (same as a yard whip) is heaved in by the receiving ship to move the load over. An in-haul line (same as a hatch whip) on the delivering ship returns the trolley for another load. The wire high-line is the standard procedure in trans-

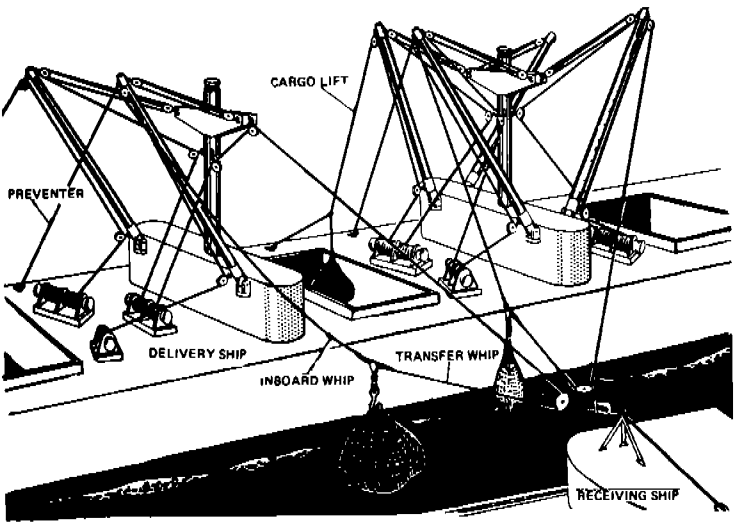

Figure 19.19. A double housefall rig.

ferring cargo to destroyers and other small ships, and at times is the best means of transfer to large ships. In order to use this method, the receiving ship must have a place in her superstructure high enough and strong enough to attach the highline.

Synthetic highline rig. This is the same as the wire highline rig, except that a synthetic (double-braided polyester) line is used instead of wire. Only light cargo can be handled. The receiving ship needs only a snatch block (block that can be opened up so that a line can be run through without using the bitter end of the line) attached to a padeye. The highline is kept taut during transfer either by 25 line handlers or by a capstan. The capstan cannot be used if personnel are being transferred. The trolley that rides the highline is moved by inhaul and out-haul lines, each handled by a minimum of ten personnel on deck. This rig is easily and quickly set up and is the safest method of transferring personnel from ship to ship.

STREAM rig. STREAM is an acronym for Standard Tensioned Replenishment Alongside Method. A wire highline is kept taut by a specially designed ram-tensioner assembly that automatically adjusts the tension as the two ships surge in and out (getting closer and farther away from each other), which inevitably happens as the ships steer into varying sea and wind conditions. With this stable line kept high and taut by the ram-tensioner, trolleys can be efficiently run

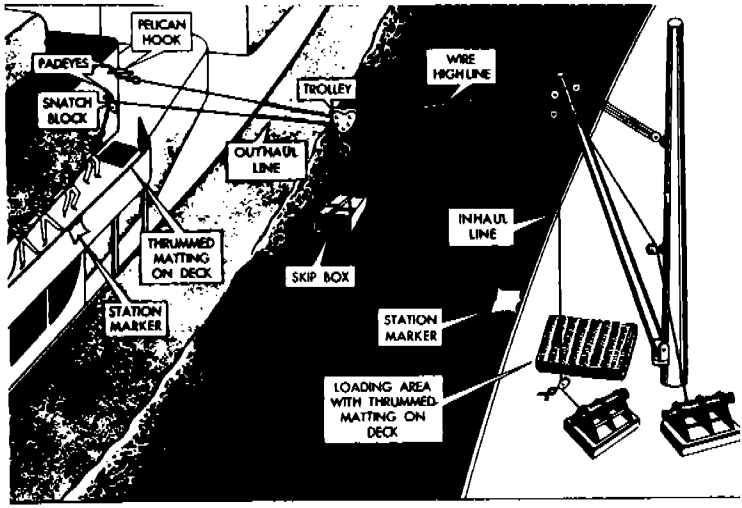

Figure 19.20. Wire highline rig.

back and forth on the wire. A device called a *traveling SURF* (standard UNREP receiving fixture) is sent over to the receiving ship and attached. This SURF combines in one device the wire tensioned highline and a combined in-haul/out-haul system that is used to run the trolley back and forth. This method has the advantage of simplicity for the receiving ship; she need only attach the traveling SURF to a secure point and everything that is needed is provided and controlled by the delivering ship. It also allows the ships to steam alongside at a safe distance (as much as 300 feet apart). This method can be adapted for transferring cargo or fuel.

Fueling at Sea

The method of fueling at sea depends upon the ships involved, the kind of fuel being transferred, and the weather and sea conditions. The various rigs differ mainly in the method by which the delivering ship sends the hose over to the receiving ship.

In the *conventional span-wire rig* the fuel hose is supported on a heavy wire that is attached to the receiving ship. This method allows the ships to refuel while maintaining an alongside distance of between 140 and 180 feet, which is a relatively safe distance that does not require any extraordinary shiphandling skills.

When the receiving ship is not equipped to handle a span-wire rig, the *close-in rig* is used. In this method, the hose is supported by whips leading from the hose-carrying saddles to booms, king posts, or other points high enough on the delivery ship to provide adequate support to keep the hose up and out of the water. This method (as you may have figured from its name) requires the ship to come in much closer than when using the span-wire rig—a 60- to 80-foot distance is required to effectively employ this method.

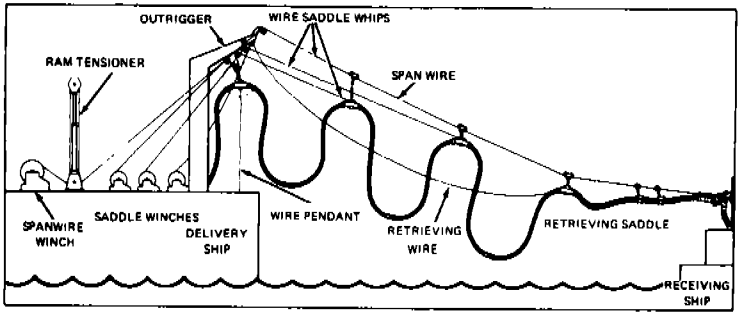

Figure 19.21. A typical refueling STREAM rig.

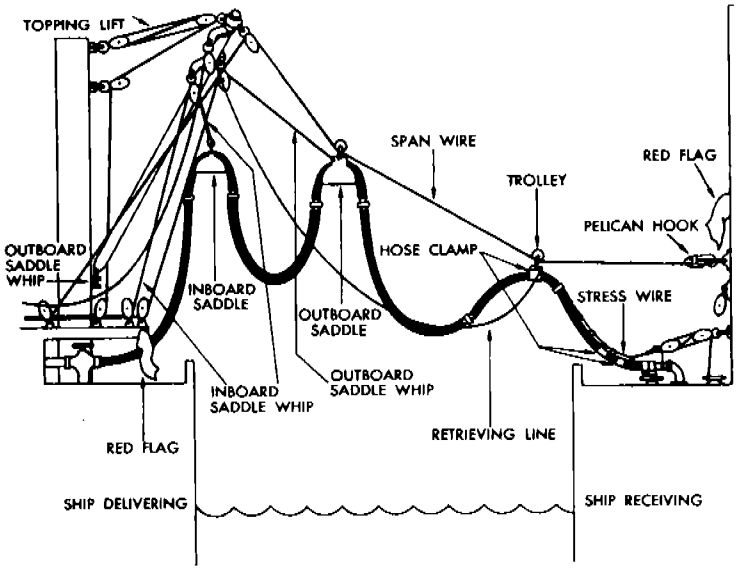

Figure 19.22. A span-wire rig.

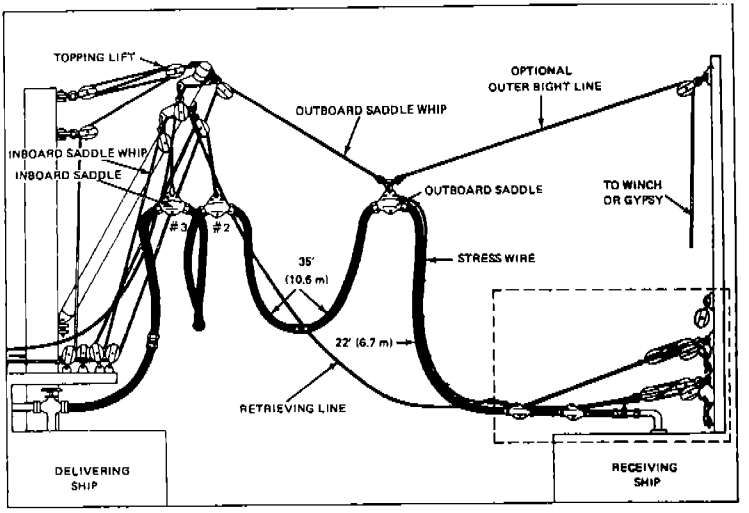

Figure 19.23. A close-in refueling rig.

The *fuel STREAM* rig is the same method used for transferring cargo (see above), having the advantages of simplicity for the receiving ship and a safer working distance.

Vertical Replenishment

Helicopters are often used to replenish stores and ammunition while ships are underway. Called *vertical replenishment* (VERTREP), this method can be used instead of, or at the same time as, alongside replenishment. By combining the two methods, a great deal of material can be transferred in less time. A particularly efficient method is to refuel alongside while receiving ammunition and/or stores via VERTREP. The two ships need not be alongside if VERTREP is the

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Figure 19.24. A CH-46 Sea Knight helicopter lowers cargo to the flight deck of an aircraft carrier during a VERTREP.

only method of replenishment being used. The distance is limited only by the range of the helicopter(s) being used.

Cargo can be carried internally, but the preferred method is to sling it from a hook on the bottom of the helicopter. The load capacity of a Navy helicopter with an external load is as much as 7000 pounds.

Almost any ship can be replenished by helo if she has even a small open area for landing cargo, a larger unobstructed area overhead in which the helo can hover, and unobstructed access to the hover area so that personnel can clear out the delivered cargo.

20 Boats

The term "boat" refers to small craft limited in their use by size and usually not capable of making independent voyages of any length on the high seas. Do not make the mistake of calling a *ship* a "boat." It will mark you as a real landlubber.

The Navy uses thousands of boats, ranging from 9-foot dinghies to 135-foot landing craft. They are powered by either diesels, outboard gasoline motors, or waterjets. Most boats are built of aluminum, fiberglass, or steel. Newer Navy boats are designed and built using the International System of units (also known as SI or metric), but older craft were designed using the English units system (feet, inches, and so on).

Standard Boats

A standard boat is a small craft carried aboard a ship to perform various tasks and evolutions.

Landing Craft

These boats, carried by various amphibious ships, are designed to carry troops, vehicles, or cargo from ship to shore under combat conditions, to unload, to retract from the beach, and to return to the ship. They are especially rugged, with powerful engines, and they are armed. Landing craft are usually referred to by their designations (such as LCM or LCU) rather than by full names.

The principal types are the LCPL (meaning landing craft, personnel, large), LCM (landing craft, mechanized), and LCU (landing craft, utility). The most common in today's fleet are the LCMs.

There are two types of LCMs. Both types have a power-operated bow ramp, a cargo well, twin engines, and after structures that house enginerooms, pilot houses, and stowage compartments. The larger version, designated LCM-8 and often called "Mike 8," is 74 feet long, has a 21-foot beam, and is capable of carrying a heavy tank or

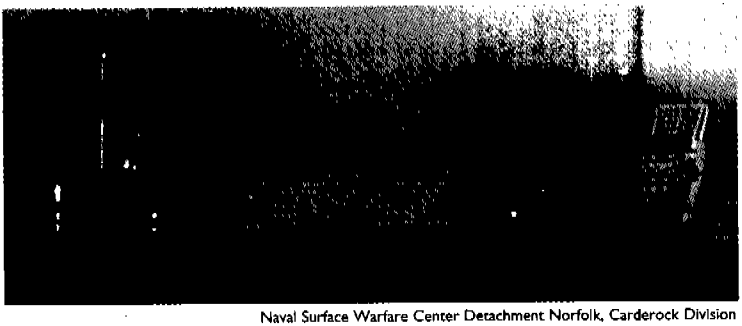

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Figure 20.1. Landing craft, mechanized (LCM-6).

60 tons of cargo. The LCM-6 ("Mike 6"), is 56 feet long, has a 14-foot beam and a cargo capacity of 34 tons.

A much more sophisticated landing craft used in today's fleet is the LCAC (landing craft, air cushion). As you can tell by the name, this unusual craft floats on a cushion of air that allows travel over water and right up onto land to deliver troops, equipment, and supplies. They can clear an obstacle up to four feet high. They are 81 feet

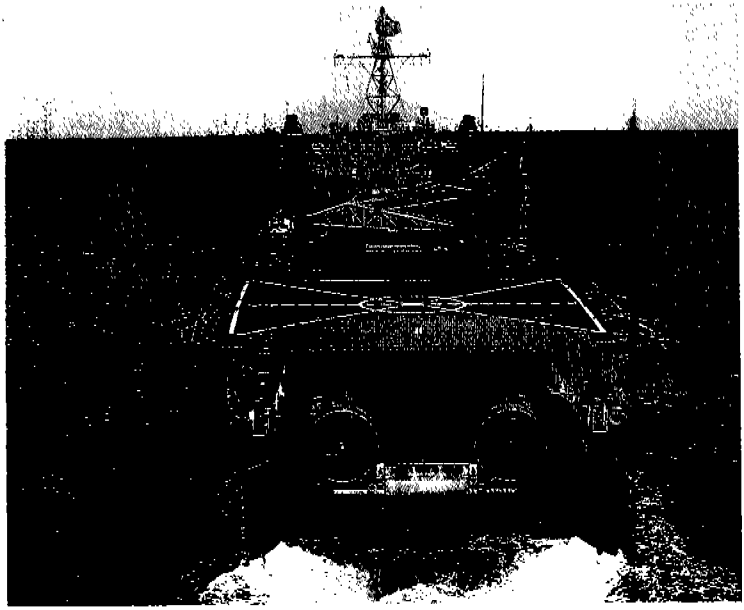

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Figure 20.2. An LCAC in the well deck of an LSD.

long and can carry a variety of vehicles or a load of more than 70 tons. Powered by four gas turbine engines, they are capable of speeds as high as 50 knots.

Workboats (WB)

There are two types of WBs, the 30-foot and the 15-meter (or 50-foot). The 35-foot WB is a twin screw craft with a forward cargo well and a bow ramp. The 35-foot WB is normally carried on board salvage ships and is used to assist ships in salvage operations, although it has been used for diving operations, underwater exploration, coastal survey, repair of other craft, and cargo transport between ships and shore. A portable "A-frame" is used to assist with cargo handling.

The 15-meter (50-foot) WB is a twin screw craft with steel hull construction and is a shallow draft cargo carrier. The 15-meter (50-foot) WB is intended for general-purpose missions and transportation of cargo. The craft has a pilot house aft and a forward cargo well deck.

Rigid Hull Inflatable Boats (RHIB)

These are versatile boats designed for service as a standard ship's boat. The seven-meter (24-foot) RHIB is a turbocharged, diesel-powered craft with a glass-reinforced plastic (GRP) hull. The hull form is

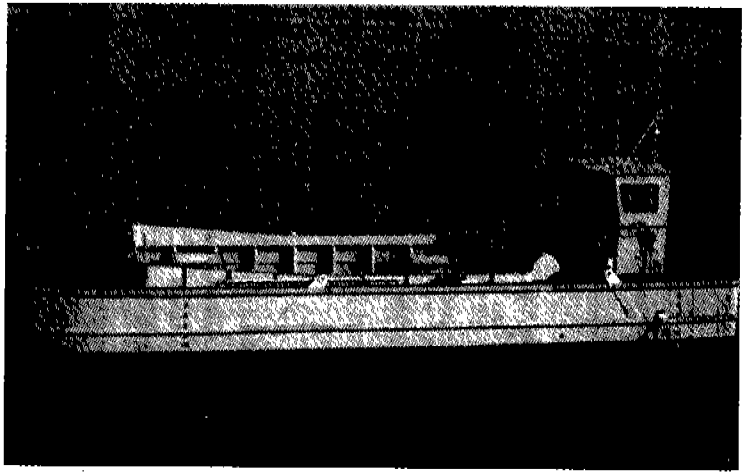

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Figure 20.3. A 15-meter workboat.

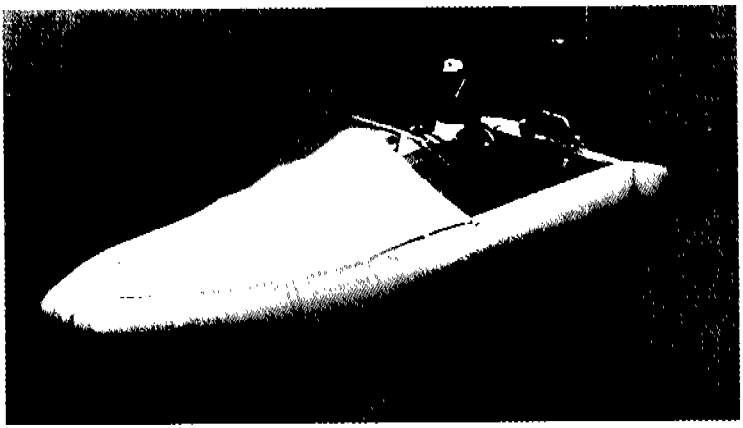

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Figure 20.4. Rigid hull inflatable boats (RHIB) have a glass-reinforced plastic hull.

a combination of a rigid planing hull with an inflatable tube. The craft are manned by a three-man crew and are provided with a canvas canopy forward.

Personnel Boats (PE or PERS)

These are fast, V-bottomed, diesel-powered boats with enclosed spaces specifically designed to transport officers, although smaller types are used for shore-party boats, lifeboats, and mail boats. They

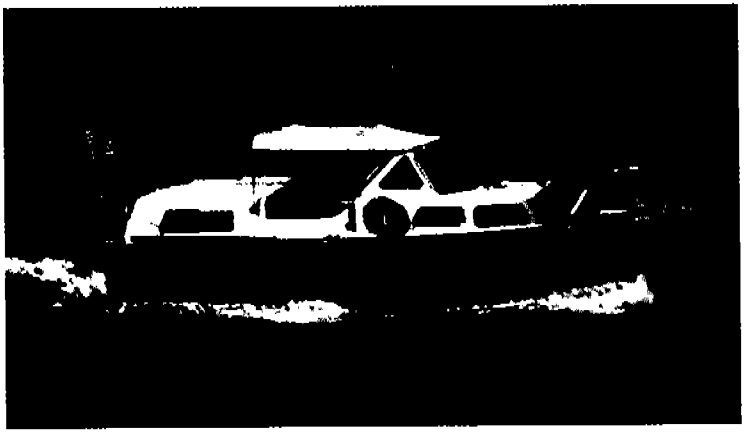

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Figure 20.5. Personnel boats may become "gigs" when assigned to commanding officers, or "barges" when assigned to flag officers.

come in 8-, 10-, and 12-meter (26-, 33-, and 40-foot) lengths. The 8-meter (26-foot) boats have one enclosed cabin. The 10- and 12-meter (33- and 40-foot) boats have enclosed cabins forward and aft, and open cockpits amidships where coxswains steer by wheel. Those designed for officers are painted haze gray with white cabins. Those assigned for use by commanding officers, chief of staff, and squadron, patrol, or division commanders are called gigs and have a red stripe added just above the waterline. Personnel boats assigned to flag officers (admirals) are called barges. They have black hulls and a white stripe just above the waterline.

Utility Boats (UB)

These boats, varying in length from 18 feet to 15 meters (50 feet), are mainly cargo and personnel carriers or heavy-duty work boats. Many have been modified for survey work, tending divers, and minesweeping operations. In ideal weather, a 15-meter (50-foot) UB will carry 146 people, plus crew. Utility boats are open boats, though many of the larger ones are provided with canvas canopies. The smaller utility boats are powered by outboard engines. The larger boats have diesel engines.

Punts

These are open square-enders, 14 feet long. They are either rowed or sculled, and are generally used in port by side cleaners.

Special Boats

These boats, used by shore stations and for special missions, are not normally carried aboard ships as are the standard boats discussed

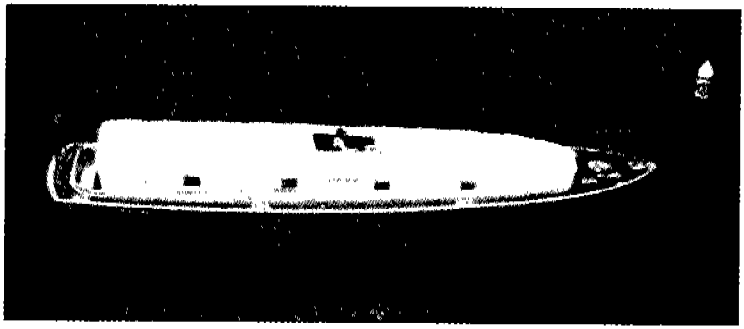

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Figure 20.6. This 15-meter (50-foot) utility boat can carry 146 people.

above. They include line-handling boats, buoy boats, aircraft rescue boats, torpedo retrievers, explosive ordnance disposal craft, utility boats, dive boats, targets, and various patrol boats. Many standard boats have been modified for special service.

Mark V Special Operations Craft (SOC)

This craft is also used for insertion and extraction of special warfare personnel. The craft is 82 feet long, and has twin diesel engines driving waterjets. The craft is capable of speeds in excess of 50 knots and is air deployable.

Patrol Boat, River (PBR)

This is a 31-foot, 25-knot, twin-diesel boat with a fiberglass hull and waterjet-pump propulsion that permits it to operate in 15 inches of water. The PBR is highly maneuverable and can reverse course in its own length. It carries radar, communications equipment, and machine guns.

Boat Crews

Most boats have permanently assigned crews. Crew size varies depending on the type of boat, but typically consists of the coxswain, engineer, and bowhook and sometimes a sternhook and boat officer. All must be qualified swimmers.

The boat crews represent their vessel and should for that reason take pride in their appearance and that of their boat. The efficiency and smartness of a ship's boats and boat crews reflect the standards of the ship. Clean white uniforms can be hard to maintain on some ships, but custom dictates that every day the ship's laundry wash and press a uniform for each member of the duty boat's crew. Ship regulations frequently require crewmembers to wear sneakers. This is a safety factor, but it also keeps the boats themselves looking good.

Coxswain

The coxswain is in charge of all personnel and equipment in the boat. Subject to the orders of the OOD and the senior line officer embarked, a coxswain otherwise has full authority and is responsible for the boat's appearance, safety, and efficient operation. The crew and passengers (including embarked troops) are required to cooperate fully with the coxswain. In fulfilling his or her responsibilities, the coxswain must be familiar with all details relating to the boat's care and handling. Equally important, the coxswain must be able to

instruct the crew in all aspects of the general service and drills. The coxswain is also responsible for the appearance and behavior of the crew.

Engineer

The engineer must see that the engine is in good condition and ready to run. Only the engineer should work on the engine. The engineer may also perform the duties of the sternhook.

Bowhook

The bowhook handles lines forward when the boat is coming alongside a pier or ship. The bowhook also tends fenders and forward weather cloths (canvases spread for protection against the wind). In an open boat, the bowhook usually sits on the forward thwart (crossseat) on the starboard side, outboard. In bad weather, she or he may move to the lee side. The bowhook faces the bow and serves as a lookout. If the boat is decked over, the bowhook stands on the starboard after deck facing forward.

When the boat approaches the landing, the bowhook should be ready to spring ashore with the painter (a length of line secured to the bow of the boat for towing or making fast) and take a turn on the nearest cleat. When the boat approaches a ship's side, the bowhook should be in the bow with the boathook, ready to snag the boat line and make it fast. The bowhook should always have a fender ready to drop over the side if a bump is unavoidable.

Sternhook

The sternhook, likewise, should be ready at once to jump ashore with the stern line. In an open boat, the sternhook normally sits on the starboard side, outboard on the after thwart, facing aft. On decked-over craft, the sternhook usually stands on the port side of the after deck, facing forward.

Boat Officer

During heavy weather, and other times as deemed necessary, an officer (sometimes a chief petty officer) is assigned to each duty boat. A boat officer naturally has authority over the coxswain. The boat officer does not assume the coxswain's responsibilities, or relieve the coxswain of his or her normal duties, but is there to oversee the boat operations to ensure that safety is maintained at all times. The situation is somewhat like the relationship between the OOD and the com-

manding officer on the bridge. The coxswain and boat officer are responsible for the boat and for the safety and welfare of the crew and passengers.

Care of Boats

Maintenance greatly increases a boat's service life and assures its operational readiness. The boat crew takes great care to prevent corrosion of metal-hulled boats by maintaining the paint and specified preservation coatings in good condition and ensuring that the proper number of zincs are used to prevent electrolytic corrosion.

Maintenance and repair of fiberglass hulls involve the same materials and techniques used on sports cars. Do not use laminates, resin, or hardeners without fully reading the enclosed instructions.

Repair minor damage, tighten loose bolts, and fix or replace leaking gaskets as soon as possible to prevent more repairs later. Secure all loose gear to avoid damage when the water gets rough. Keep the boat and its equipment free of dirt, corrosion, and accumulated grease.

Proper preventive maintenance is essential. Engine oil changes, battery servicing, and other maintenance should be performed in accordance with the planned maintenance system (PMS) for the boat. Gear housings, steering mechanisms, and other moving parts must be well lubricated. Fenders should be placed between boats when they are tied up. All rubber exhaust couplings should be checked for tightness and condition. When a boat is hoisted out of the water, the struts, propeller, sea suctions, and shaft bearings should be checked. Dog-eared propellers or worn shaft bearings cause heavy vibration, which may result in severe damage to the hull and/or engine.

Oil-soaked bilges are a fire hazard. When draining or filling fuel tanks or engine crankcases, avoid spilling diesel fuel or engine oil.

Boat Customs

Just as Navy ships adhere to certain customs and traditions, so do Navy boats.

Etiquette

Whenever Navy personnel board a boat, junior personnel embark first and seniors last. When the craft arrives at its destination, seniors will disembark first and juniors last. While embarked, seniors sit aft and juniors forward.

Salutes

When underway, it is customary for boats to exchange salutes just as personnel and ships do. The coxswain (or boat officer, if embarked) will attend to all salutes, and the coxswain of the junior boat will initiate the salute and idle the boat's engine during the exchange. The rest of the boat crew will stand at attention. Passengers will remain seated but come to seated attention (sit erect, looking straight ahead and not talking).

Flags and Pennants

The national ensign is displayed from Navy boats when:

they are under way during daylight in a foreign port;
ships are dressed or full dressed;
they are alongside a foreign vessel;
an officer or official is embarked on an official occasion;
a uniformed flag or general officer, unit commander, commanding officer, or chief of staff is embarked in a boat of his or her command or in one assigned for his or her personal use; or
when prescribed by the senior officer present.

Since small boats are a part of a vessel, they follow the motions of the parent ship regarding the half-masting of colors.

When an officer in command is embarked in a Navy boat, the boat displays from the bow the officer's personal flag or command pennant—or, if not entitled to either, a commission pennant.

In a boat assigned to the personal use of a flag or general officer, unit commander, chief of staff, or commanding officer, or when a civil official is embarked, the following flagstaff insignia are fitted at the peak:

Spread eagle. For an official whose authorized salute is 19 or more guns (secretaries of the Navy, Army, Air Force, Chief of Naval Operations, Commandant of the Marine Corps, and so on).

Halberd. For a flag or general officer whose official salute is fewer than 19 guns and for a civil official whose salute is 11 or more, but fewer than 19 guns (assistant secretaries of defense down to and including consul generals).

Ball. For an officer of the grade or relative grade of captain in the Navy and for a career minister, counselor, or first secretary of an embassy, legation, or consul.

Star. For an officer of the grade or relative grade of commander in the Navy.

Flat Truck. For an officer below the grade or relative grade of commander in the Navy, and for a civil official on an official visit for whom honors are not prescribed.

The head of the spread eagle and the cutting edges of the halberd must face forward. The points of the star must face fore and aft.

Boat Markings

Admirals' barges are marked with chrome stars on the bow, arranged as on the admiral's flag. The official abbreviated title of the flag officer's command appears on the stern in gold letters—CINCPACFLT (for Commander-in-Chief Pacific Fleet), for example.

On gigs assigned for the personal use of unit commanders not of flag rank, the insignia is a broad or burgee replica of the command pennant with squadron or division numbers superimposed. The official abbreviated title of the command, such as DESRON NINE, appears on the stern in gold letters.

The gig for a chief of staff not of flag rank is marked with the official abbreviated title of the command in chrome letters, with an arrow running through the letters. Other boats assigned for staff use have brass letters but no arrows.

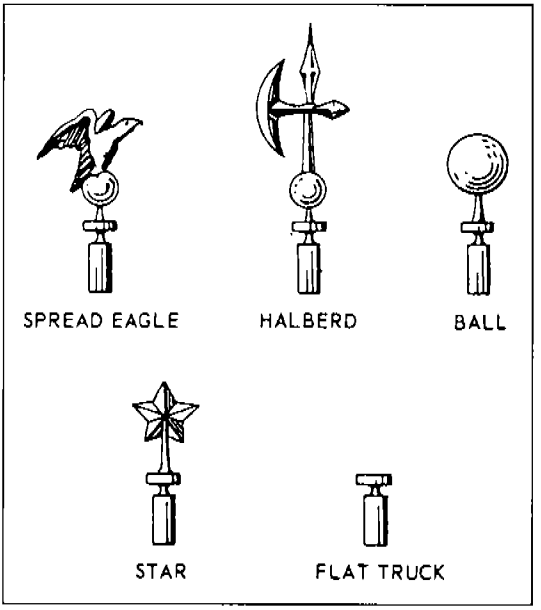


Figure 20.7. Flagstaff insignia.

Boats assigned to commanding officers of ships (gigs) are marked on the bow with the ship type or name, and with the ship's hull number in chrome letters and numerals. There is a chrome arrow running fore and aft through the markings. On boats for officers who are not in command or serving as chiefs of staff, the arrow is omitted and letters are brass. The ship's full name, abbreviated name, or initials may be used instead of the ship's type designation. An assigned boat number is sometimes used instead of the ship's hull number.

Other ship's boats are marked on the bow either with the ship's type and name or with her initials, followed by a dash and the boat number—for example, ENTERPRISE-1. These markings also appear on the stern of most boats. Letters and numbers are painted black. Numerals are painted as identifiers on miscellaneous small boats such as line-handling boats, punts, and wherries.

Boat Equipment

Every Navy boat in active service must have a complete outfit of equipment for meeting any ordinary situation. It is necessary to requisition part of the outfit. The coordinated shipboard allowance list (COSAL) lists items allowed for each boat. When a boat is turned in, its outfit also must be turned in, unless the boat is to be replaced by another of the same type. In that event, the outfit is retained. If a boat is to be replaced by one of a different type, the only items retained are those allowed for the new boat.

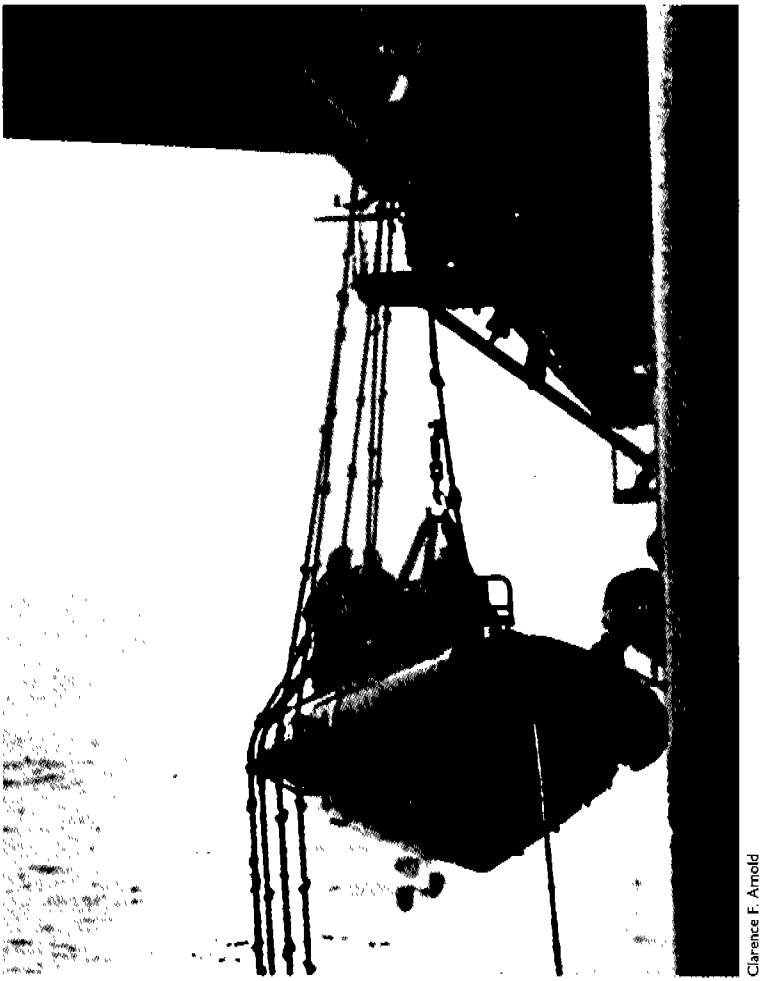
Hoisting and Launching Boats

The process of hoisting and lowering boats with a crane or davits is potentially dangerous and should be approached with the utmost attention to safety.

Launching

Before swinging out a boat to be lowered, first make sure that the hull drain plugs are in. Each person in the boat wears a life jacket, hard hat, and has a lifeline (monkey line) in hand. Run your sea painter outboard of everything on the ship, to the ship side of the bow, and belay with a toggle, so you can let it go without difficulty.

The boat's engine is started while the boat is in the air, but the clutch is never engaged until the falls are unhooked and hauled clear. In releasing the boat, the after fall is always unhooked first. Before starting ahead, take care that there are no trailing lines astern that



Clarence F. Arnold

Figure 20.8. Hoisting and launching boats is an important seamanship skill.

might foul the screw. When the boat runs ahead and the painter slackens, the painter is thrown off by pulling out the toggle. The sea painter is hauled back to the ship by the light line attached to it.

Hoisting

When a boat comes alongside an underway ship to be hoisted in, it first secures the end of the sea painter. The shipboard end of the line is bent securely to a cleat or a set of bitts. The boat end of the painter

is lowered by a light line and made fast to a forward inboard cleat. The sea painter is never bent to the boat's stern or to the side of the bow away from the ship. If it is, the boat, when riding to the painter, will dive against the ship's side and perhaps capsize. It is also important that the boat be driven ahead and allowed to drop back on the sea painter to position itself exactly under the crane before lifting. Otherwise, it may broach to (turn crossways to the flow of water) and capsize as it starts to leave the water.

Once the boat rides to the painter, its engine is secured and the slings are attached. Steadying lines are secured to the cleats on the outboard side of the boat and brought back on deck to hold it steady as it rises. The bowhooks and sternhooks must fend if off the side.

Davits

Davits are devices specially designed to hoist and stow boats aboard ship. Hoisting boats with double-arm davits is somewhat more complicated than lifting them with a crane. The boat is attached to the sea painter in the same manner as with a crane—particularly if the ship has headway and must therefore take the same precautions against broaching to when the boat is lifted.

There are a number of different kinds of davits in use in the Navy.

Gravity davits are found on newer ships. Power is not required to lower boats. The boat lowers by gravity as it is suspended from the falls, and the descent speed is controlled with the boat's davit-winch manual brake. Several types of gravity davits are used. Depending on the design, a pair of modified davits may handle one to four boats; they are designated as single-, double-, or quadruple-davits. These are used mainly with amphibious craft.

An *overhead suspended davit* is a special gravity davit used beneath a sponson or other overhang found on aircraft carriers and helicopter landing ships.

A *slewing arm davit (SLAD)* is a mechanical davit with a single arm. The davit arm is mounted on a pedestal and rotates about a vertical axis when moving the boat outboard and inboard in a slewing type motion.

A *trackway davit* is a gravity davit consisting of an arm or arms mounted on rollers that run on an inclined trackway or trackways that are mounted on the deck. The incline on the trackway(s) is sufficient for gravity to cause the boat and arm(s) to move down the trackway(s) from the inboard position to the outboard position so that the boat may be lowered into the water.

Ready Lifeboat

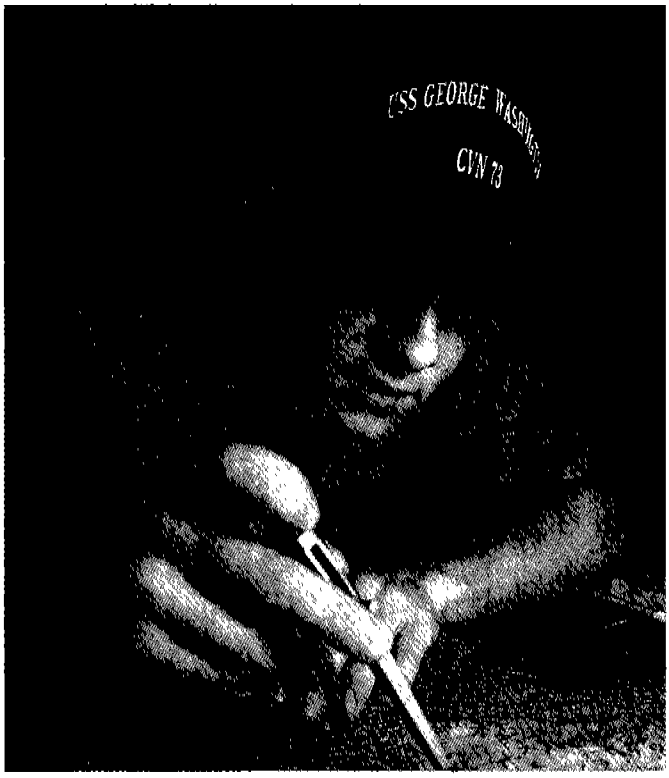
Regulations require that a ship at sea have at least one boat rigged and ready to be lowered for use as a lifeboat. The ship's boat bill states the exact specifications a lifeboat must meet and the equipment it must have.

At the start of each watch, the lifeboat coxswain musters the crew, checks the boat and gear, has the engine tested, and reports to the OOD. Depending upon current operations, the crew may be required to remain near the boat.

The ready lifeboat, usually a RHIB, is secured for sea in the davits, ready for lowering. The lifeboat has its sea painter already rigged, and the lifelines are cleared for running. The boat should have a full tank of fuel, and the lubricating oil reservoir should be full. Keep an extra can of oil on board. The bilge should be clean and dry and the boat plug in place. Life-jackets are to be ready nearby or in the boat so the crew may don them quickly before lowering away.

21 Navigation

Every Sailor—even if she or he is an engineer, storekeeper, or airman—must have an understanding of basic navigational techniques. Living and working in the Navy you will serve in ships or at least have some contact with them. You may be tasked with standing a lookout watch or expected to help during a shipboard evolution that will require some knowledge of the skills discussed in this chapter.



PHAN Joe Hendricks

Figure 21.1. Every Sailor must have an understanding of basic navigational techniques.

Knowing what a ship is doing and why it is doing it will greatly enhance your experiences at sea, even if you are not directly involved in the actual operations. Ships rely on boats for a variety of routine and emergency purposes and you may find yourself in a boat needing some basic navigational skills.

Elements of Navigation

Navigation is all about finding your position on the earth and then successfully moving to another position. The skills needed are based to a large degree on your ability to measure distance, speed, direction, and time. You may already have a good working knowledge of some of the skills and techniques described in this chapter. Others will probably be new to you.

Position

What you would call your "location" in civilian life is called *position* in nautical navigation. Using such things as visual bearings and radar ranges and then plotting them on nautical charts, navigators can determine their position.

Latitude and Longitude

To be able to pinpoint our position anywhere on the earth, ancient geographers came up with a grid system that covers the earth with imaginary lines called *latitude* and *longitude*.

Knowing that the earth spins on what is called its *axis* (notice that this word is similar to "axle," which is what a wheel turns about), these geographers chose the two points where the axis passes through the earth as their initial points of reference, calling them the *North* and *South Poles*.

Because these early geographers were Englishmen and England was, to them, of prime importance, they drew a line from one pole to the other that passed through the town in England where the Royal Naval Observatory was located—Greenwich—and called this line the *prime meridian* (sometimes called the *Greenwich meridian*). The rest was easy after that. They next extended the line up the other side of the world, so that it divided the earth into two halves. This other line—opposite the prime meridian—is called the *international date line*.

Another line was drawn at right angles to this prime meridian/international date line, exactly halfway between the poles, and was named the *equator*.

More lines were then constructed to gird the entire earth in a grid system. Lines drawn parallel to the equator are called parallels of latitude and lines drawn like the prime meridian (through the poles) are called lines of longitude.

The location of any place on Earth can be described by its latitude (the distance north or south of the equator) and longitude (the distance east or west of the prime meridian). Latitude is measured in degrees north or south of the equator, with 0 degrees at the equator and 90 degrees at each pole. Longitude is measured in degrees from the prime meridian, either east or west, and 180 degrees each way (until they meet at the international date line) so that they total 360 degrees. When a position is described using latitude and longitude together, it is often referred to as the position's *coordinates*.

For more precise measurements, degrees can be subdivided into *minutes* and they can be further subdivided into *seconds*. There are 60 minutes in a degree of latitude or longitude and 60 seconds in a minute.

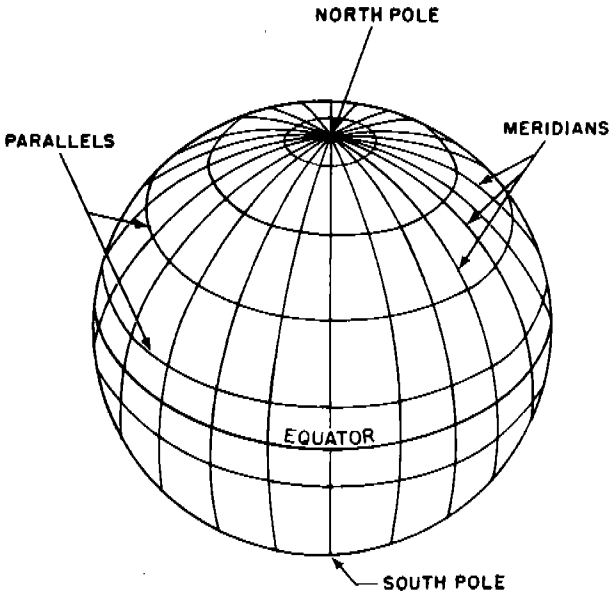


Figure 21.2. Parallels of latitude and meridians of longitude enable us to pinpoint a position anywhere on the earth.

Degrees are normally written using a small circle, minutes are written using a small symbol that looks like an apostrophe, and seconds are written using something that looks like quotation marks. So, "seventy-seven degrees, eighteen minutes, and eleven seconds" would be more simply written as 77°18′11″.

Using this standardized system of longitude and latitude, you can describe any point on Earth with great precision and consistency. For example, if you are standing in downtown Cleveland, Ohio, your position would be at coordinates 41°30′07″N and 81°45′17″W (read "forty-one degrees, thirty minutes, seven seconds north" and "eighty-one degrees, forty-five minutes, 17 seconds east"). Anyone with a map of Ohio could find your position with great precision using these coordinates.

Charts

On land, these positions would be plotted on maps that have latitude and longitude grids superimposed on them. But for plotting positions in the oceans, along shorelines, or on the waterways of the world, we use what are called *charts*. These, too, are marked with latitude and longitude lines and can be used to pinpoint positions, even in the middle of the world's largest oceans.

Distance

To find how far you are from land or how far you have to go to reach a rendezvous point, you will need some means of measuring distance. At sea, distance is measured in *nautical miles*. It is important for you to realize that a nautical mile and a land (or statute) mile are not the same. A nautical mile is about 6076 feet, or roughly 2000 yards. A land mile is 5280 feet. While this difference is not much (796 feet) when we are talking about one mile, it can become very significant when hundreds (or even thousands) of miles are involved.

A very useful aspect of the nautical mile is that it is equal to approximately one minute of arc measured along any meridian. On a map using land miles, you must refer to a mileage scale in order to measure distance, but because a nautical chart will always have longitude marked on it, you will have a handy reference for measuring distance simply by comparing it to the number of minutes of latitude along a nearby meridian.

Speed

In nautical navigation, speed is measured in *knots*, a seaman's term that means nautical miles per hour. Do not show yourself to be a

landlubber by appending the words "per hour" to a ship's speed in knots. For example, a ship makes 27 knots, never 27 knots per hour.

Remember that a nautical mile is longer than a land mile. This means that a ship making 25 knots is traveling faster than a car on land that is clocked at 25 miles per hour. (In one hour, the ship will have traveled 151,900 feet [25 × 6076] while the car will have only gone 132,000 feet [25 × 5280].)

Direction

This is determined by a compass. You are probably already familiar with the four cardinal directions of north, east, south, and west. In the days of sail, when ships could not be steered with a great deal of accuracy, compasses with 32 divisions called *points* were the standard. These points had names such as "northwest-by-north" and "east-southeast."

Modern vessels can be steered much more accurately, so modern compasses have *360* divisions called *degrees*. Directions are always expressed in three digits and are measured clockwise from north, so east is 090 degrees, south is 180 degrees, west is 270 degrees, and

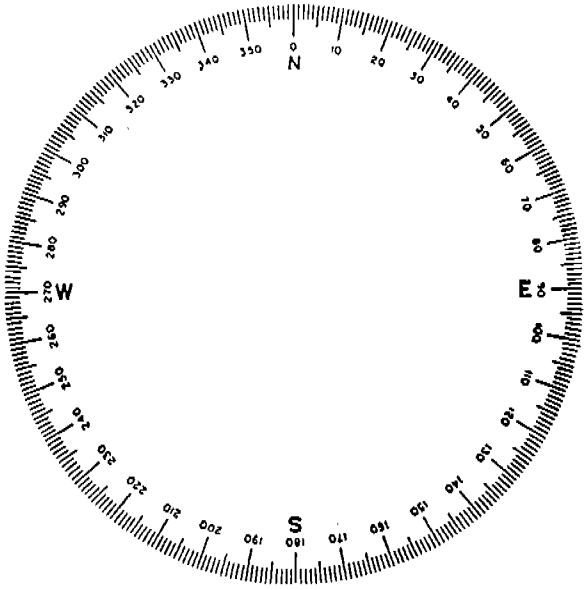


Figure 21.3. Modern compasses have 360 divisions, called degrees.

north is either 360 or 000 degrees, whichever designation is most convenient.

Nautical charts have what is called a *compass rose* printed on them (often there is more than one on a chart) which is used to determine accurate directions on the chart. Using a compass rose and the appropriate instruments, you can plot and measure lines in specific directions on a chart.

When ships steer in a specific direction, it is called a *course*. When you sight an object that is in a given direction from your ship, it is called a *bearing*.

Time

As already discussed in chapter 1, the Navy always uses 24-hour time, not civilian time with its confusing "A.M." and "P.M." designations. Some other things about time in the Navy are important not only for navigation but for clear communications and consistency of operations. Because, as a Sailor in the U.S. Navy, you are (either potentially or actually) a world traveler, you need to have an understanding of some of the fundamentals of world time.

You probably are aware that people living on the West Coast of the United States are in a different time zone from those living on the East Coast and that when it is 0800 in California, it is 1100 in New York. For convenience and to allow for the daily passage of the sun as the earth rotates on its axis, the entire world is divided into time zones.

Because there are 24 hours in the day and we know there are 360 degrees of longitude, it makes sense that each time zone would be 15 degrees of longitude wide ($360 \div 24 = 15$). And since the convention is to use the prime or Greenwich meridian as the beginning of longitude, it also makes sense that the first or reference time zone should be the one that includes Greenwich, England. This is called *Greenwich Mean Time* or *GMT*. The first time zone east of the one at Greenwich is one hour later (because the sun has already been there and passed on), and the first time zone west of Greenwich is one hour earlier.

In the Navy, because our ships and aircraft are mobile and often change time zones, and because it is important to military commanders to be able to refer to a common time when sending out messages to units scattered all over the earth, it is essential that we have a common reference time. For example, if the Chief of Naval Operations wanted to send out a message to all Navy submarines to report their positions at exactly the same time, he could not say simply "report at noon" because noon at San Diego is very different from noon in the Mediterranean Sea. He could say, "noon Washington, D.C., time,"

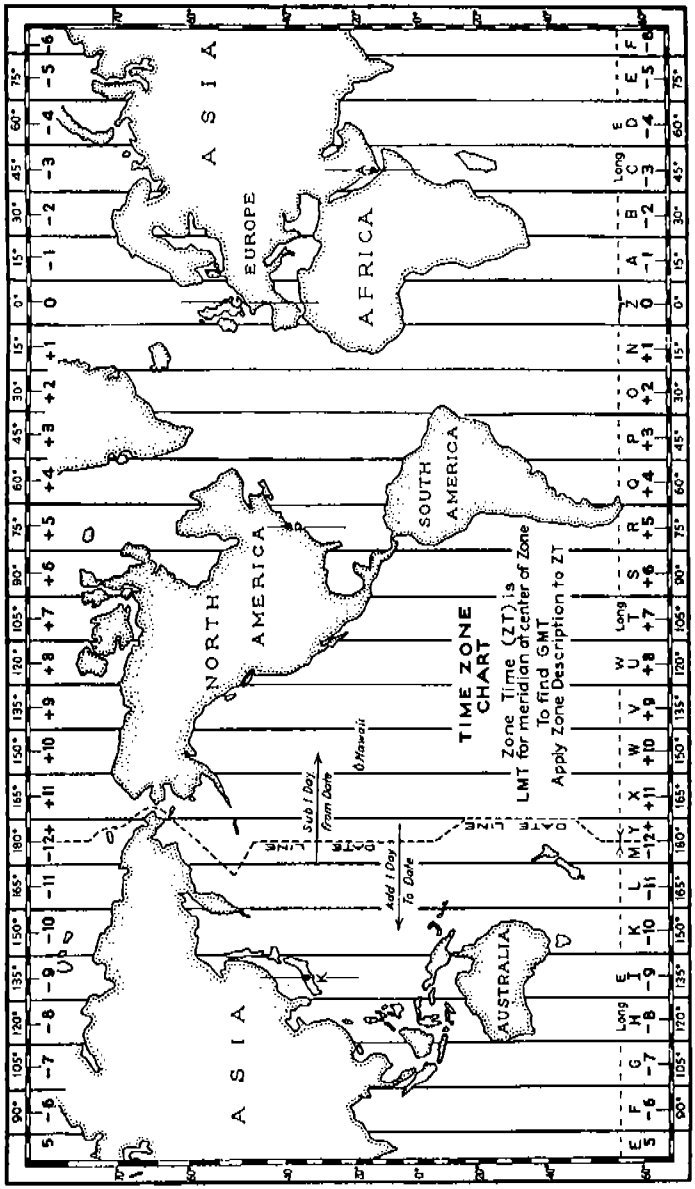


Figure 21.4. Time zone chart of the world.

but that would require every submarine to convert their local time to that of Washington. To simplify matters, the entire Navy, while keeping local time for convenience, also keeps GMT for common reference. You will often see clocks on ships (and at all naval installations for that matter) that are always kept set on GMT, no matter where in the world the ship might be. You will recognize these clocks as having been set to the reference time because they will be clearly marked either "GMT" or (more often) with a *Z* or "Zulu." This is because each time zone in the world is assigned a letter to identify it easily, and GMT is identified by the letter *Z*. You will often hear Sailors say something like "the last aircraft will take off at 0756 Zulu." This tells you that the time being used is the worldwide reference time rather than the local time.

If you look at a time-zone chart, you can see that each time zone is not only marked with a letter (Washington, D.C., is in time zone *R* or "Romeo" and Italy is in *A* or "Alfa"), but each one has a number preceded by a plus or minus sign. These numbers tell you what you need to do to convert your local time to GMT (or Zulu time). For example, Washington's Romeo time zone has the number "+5" marked on it. This means that you need to add five hours to your local time in order to know Zulu time. If it is 1322 on your wristwatch in Washington, you know the correct GMT is 1822.

Soundings

When navigating, you must obviously always be aware of the depth of the water in order to prevent your ship or boat from running aground. The depth of the water can also be a useful tool for determining your position. If you have a chart that shows the depths of the water, called *soundings,* you can use that information to help you decide where you are. For example, if your chart indicates a place where the bottom suddenly drops off into much deeper water (at an underwater cliff, for example), by watching your *fathometer* (an electronic instrument that reads the depth of the water by bouncing sound waves off the bottom) you will be able to tell when you have reached that point.

Soundings on a chart are sometimes given in feet and sometimes in fathoms. Be sure you know which your chart is using because there is a big difference (remember from a previous chapter that a fathom equals six feet). Steaming a ship with a 20-foot draft into waters that have been sounded at 11 fathoms (66 feet) is obviously a much better idea than taking that ship into 11 *feet* of water.

The Art and Science of Navigation

Mariners must rely upon a wide variety of methods, instruments, and sources of information in order to navigate effectively. Some of the techniques and practices described here you will never use, others you may use often. In any case, the professional Sailor will have a good working knowledge of the principles of navigation, and those who must navigate on a regular basis—such as quartermasters, OODs, and boat coxswains—come to appreciate why navigation is described as both an art and a science.

Methods of Navigation

Humans have been navigating the waters of the earth for thousands of years. In all that time, many means of navigation have been developed. All of them have in common the simple goal of determining one's position at sea (or in waterways), but how this is achieved can be as simple as taking visual sightings of objects on nearby land or as sophisticated as interpreting signals from a satellite orbiting the earth.

Piloting

Our earliest ancestors stayed within sight of land and used familiar landmarks to determine where they were and where they were going. This form of navigation—still used today—where the navigator relies on landmarks or on manmade navigational aids (such as buoys and lighthouses) is called *piloting*. This is the primary means of navigating when entering or leaving port or when traveling in coastal waters.

Dead Reckoning

With the invention of navigational instruments (such as the compass), navigators were able to venture onto the open sea by practicing an unreliable but better-than-nothing form of navigation called *dead reckoning*. This is simply the practice of starting from a known location and, with your compass, steering a specific heading. By calculating the elapsed time and your speed, you can come up with an estimate of where you think you are. This method can be refined by factoring in known current and wind conditions and is far better than merely blindly traveling about, but it is the least reliable means of navigation. In modern times, it is used only when no other forms of navigation are available.

Celestial Navigation

From earliest times, man has been fascinated with the night sky; this fascination eventually led to a more reliable method of navigating on the open sea, called *celestial navigation*. By using the fixed stars and the predictable planets, sun, and moon as guideposts, mariners developed ways of sighting these heavenly bodies (using a sextant). By then performing mathematical calculations they were able to figure out their own position on the earth. These methods were particularly useful on the open sea where there are no other references available. Assuming the navigator is able to get accurate sightings and performs the calculations with precision, this method is a reasonably accurate means of determining your position at sea.

Electronic Navigation

The advent of electricity ushered in a whole new realm called *electronic navigation*. Using radio beacons, radar equipment, satellites, and other sophisticated developments, mariners can now navigate with accuracy and relative ease so long as the needed electrical power is available and the sophisticated equipment is functioning properly.

Combining Methods

The true mariner never relies on just one method of navigation. Fog can obscure landmarks and buoys, making piloting difficult if not impossible. Erratic currents and compass errors can reduce the reliability of dead reckoning. Clouds can obscure the heavenly bodies, making celestial navigation impossible. And power failures or excessive moisture in an important electronic component can render the most sophisticated electronic systems totally useless. The smart navigator uses all means available to check and double-check his or her work.

Lines of Position and Fixes

The key to correlating where you are on the earth and where you are on a chart is what navigators call a *line of position* (LOP). There are many ways to obtain these LOPs and good navigators will use them all whenever they can. Two or more (the more the better) LOPs will give you a *fix*, which is your exact location on a chart.

Bearings

If you look at an object using a sighting device that is linked to a compass so that you can accurately measure its direction, you have taken what is called a *visual bearing*. For example, if you can see a

lighthouse from your ship and you sight it through an *alidade* (see "Navigational Instruments and Equipment") and see that it is exactly due north, you can then locate that lighthouse on your chart and draw a line from it that extends in a due-south direction. This is a line of position; you now have an important clue as to your whereabouts on the chart. You may be sure that your position is somewhere along that line.

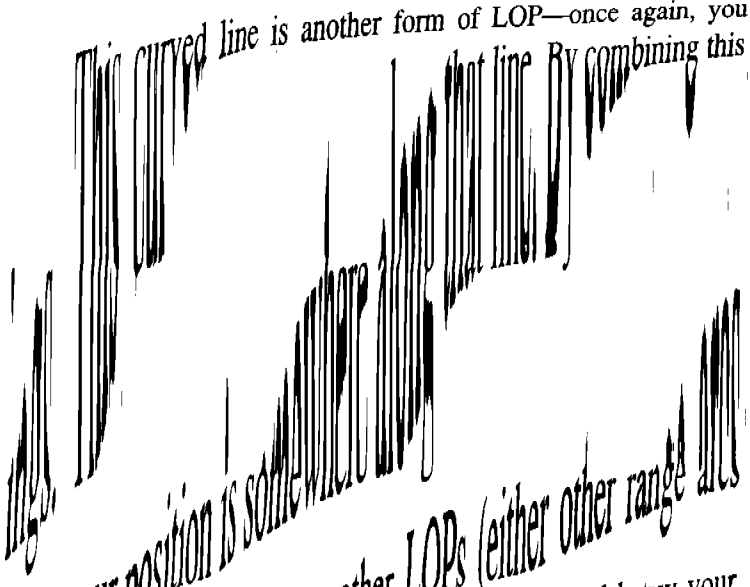
For simplicity, let us say that you can also see a watertower, and its visual bearing turns out to be due east. When you find the tower on your chart and draw a line due west from it, you have created another LOP, and again you know that you are located somewhere along that line. Where these two LOPS cross (intersect) on your chart is your exact location, and it is called a *fix.*

If you think about it for a moment, you will probably see why we draw the LOP on the chart in the direction opposite to the visual bearing we sighted. In doing so, you have used what is called a *reciprocal bearing.* You know that south is opposite north and that west is opposite east, so in our example it was easy to figure the reciprocals. But it will rarely work out that your bearings will be exactly due north or east. More often they will be something like 047° or 239°, so their reciprocal bearings are not so obvious. However, the solution is fairly simple. To get a reciprocal bearing, you must add or subtract 180°. Due north is 000°, so adding 180 gives you the reciprocal bearing of 180° (due south). East is 090°, so adding 180 gives us 270°, which is due west. Adding 180 to 047° gives us 227° and subtracting 180 from 239° yields a reciprocal bearing of 059°. In deciding whether to add or subtract the 180, remember that your answer has to be within the compass limits of 360° in order to keep it usable on your chart, so *add* if the visual bearing is less than 180° and *subtract* if the visual bearing is more than 180°.

Bearings can also be determined using radar, but they are less accurate than visual bearings and should be used with caution.

Ranges

The more LOPs you obtain, the more accurate your fix will be. You may acquire LOPs using a variety of methods. Besides the visual bearings discussed in the example above, you may obtain an LOP by taking a *range* (measuring the distance) to an object. To accomplish this, you will most likely use a radar but stadimeters and sextants (see "Navigational Instruments and Equipment") can also be used in some circumstances. When you obtain a range, you must plot it on your chart as an *arc* rather than a straight line as you did with visual bear-



Celestial LOPs

When using celestial navigation techniques, you take visual sightings of a heavenly body using a sextant and, with the aid of mathematical calculations (that you can do with the help of a computer or special tables designed just for that purpose), you can plot the result on your chart. Each sighting of a heavenly body produces an LOP and, combined with more celestial sightings or other information (such as an accurate sounding), can lead to the establishment of a fix.

Electronic LOPs

Electronic navigation techniques—whether using highly sophisticated systems such as the NAVSTAR GPS (Navigation System using Timing and Ranging Global Positioning System—usually referred to as simply "GPS") or the older Long-Range Navigation (LORAN) system—also gather information that leads to the establishment of one or more LOPs. The more sophisticated systems today seem to be producing instantaneous fixes, but in truth they are computing the received inputs and working with them in a manner similar to plotting LOPs in order to produce fixes.

Time, Speed, and Distance

Besides determining where you are at any given moment, the art of navigation is about getting where you want to go. The key elements you will need to work with to accomplish this are time, speed, and distance.

These elements are related by simple formulas that can be used to do the calculations necessary for navigation.

$$\text{Distance} = \text{Speed} \times \text{Time} \quad (D = ST)$$

$$\text{Speed} = \text{Distance} \div \text{Time} \quad (S = D/T)$$

$$\text{Time} = \text{Distance} \div \text{Speed} \quad (T = D/S)$$

In the above formulas, it is assumed that the values used are as follows:

Distance is in nautical miles.
Speed is in knots.
Time is in hours.

For example, if you know that your ship has traveled at a speed of 10 knots for 3 hours, you will have traveled 30 nautical miles ($D = ST$).

Tables and instruments available to the navigator can be used to perform these calculations, but it is useful to be able to do them manually because you might not always have these aids available and because it helps you become a better navigator if you understand these relationships.

Navigational Instruments and Equipment

Just as the chemist has her test tubes and centrifuge, and the artist has his paintbrushes and palette, the navigator has certain equipment that is used in gathering the necessary information and specialized instruments that are used in plotting that information on charts.

Compasses

One of the earliest inventions to have a major impact on the science of navigation was the compass. In its initial form—before the days of electricity—a compass relied on the magnetic properties of the earth. Later, another version that made use of the miracle of electricity was created, called a *gyrocompass*. Each has its advantages and limitations. The magnetic compass is less accurate and subject to disturbances in the magnetic field, but it will continue to function through a power failure. The gyrocompass is much easier to use and more accurate, but it must have electrical power in order to function. For these reasons, ships will have both.

Magnetic Compass

The typical magnetic compass used aboard ship consists of a floating card with magnetic needles attached which naturally align themselves with the earth's magnetic field. The floating card is supported in a bowl on a pivot in such a way that allows the card to stay in place (aligned with the earth's magnetic field) while the ship moves about beneath it. The stand in which the whole compass is kept is called a *binnacle*.

The floating card is marked with the cardinal points—North, East, South, and West—and the subdivisions in between. A line called the *lubber's line* is marked on the compass bowl and is aligned with the ship's fore and aft line. As the ship turns, the lubber's line will move with the ship and line up on the floating compass card, showing the direction the ship is headed—known in navigational terms as the ship's *heading*.

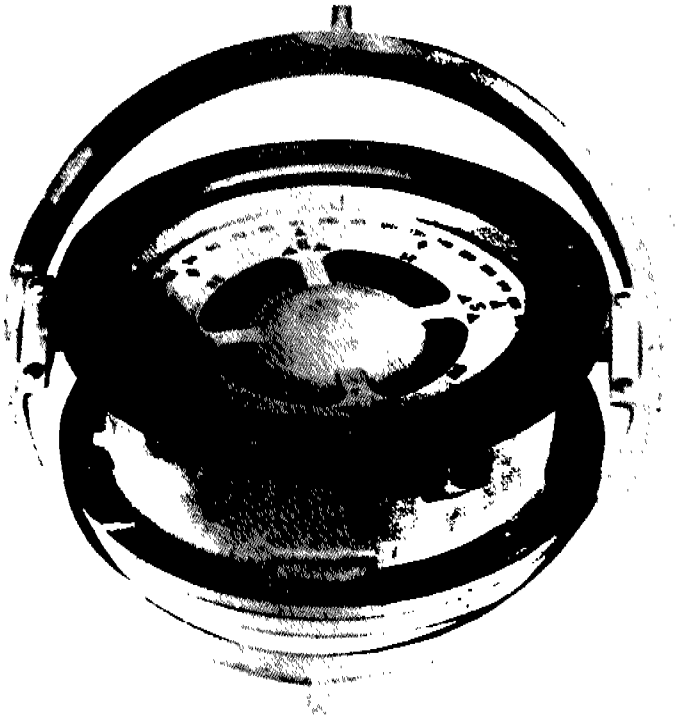


Figure 21.5. A typical Navy magnetic compass. Note the lubber's line just to the right of due East, indicating the ship's heading is between 100 and 110 degrees.

Compass Errors. The magnetic compass always points toward magnetic north. This is a near-perfect system for finding a ship's heading, but a problem arises because the magnetic north pole is not in the exact same place as the true north pole (the one that is located at the axis of the earth's rotation and is used as the starting reference for our coordinate system of latitude and longitude). Because of this difference we must always apply a correction to the magnetic heading on the compass in order to tell where true north is. This is not as difficult as it sounds because the information you need to make this correction is marked right on your chart as part of the compass rose. This difference between magnetic north and true north is called *variation*.

To further complicate things, your ship itself causes a disturbance in the natural magnetic field that the compass relies upon. This dif-

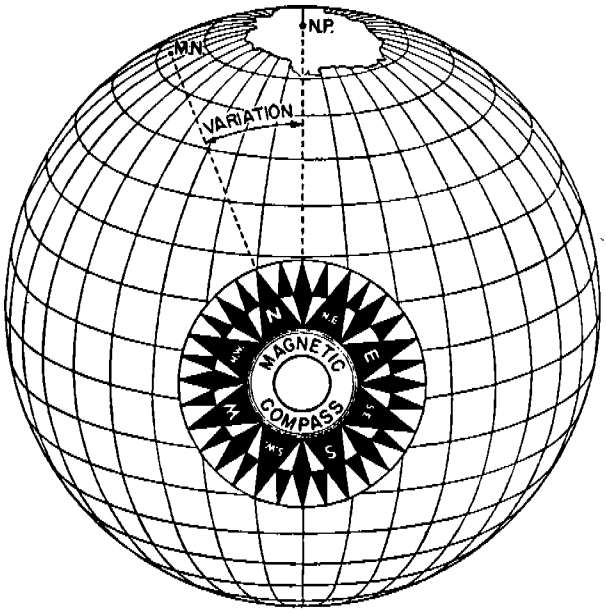


Figure 21.6. The magnetic compass aligns itself with the magnetic north pole (MN) instead of the geographic north pole (NP). The difference between the two is called variation.

ference is called *deviation* and requires another correction. The information you need to make this correction is also not far away. Each ship will have, either mounted to the binnacle or somewhere close by, a deviation table that tells you how much correction is necessary in order to convert the magnetic heading to true. A deviation table would look something like Table 21.1.

Periodically, the navigator and quartermaster perform an operation called *swinging ship* to update the deviation table for the vessel. To accomplish this, the ship steams in a complete circle from 0 to 360 degrees, and the amount of her compass deviation is noted at every 15-degree point. The results are compiled and new deviation tables made up and used from that point until the next swing ship is performed.

All compass errors (and their corrections) are described as easterly or westerly, never northerly or southerly.

Conversions. Because navigational charts can only be effectively used with *true* bearings and headings, it is important to know how to convert them from magnetic (what the compass is telling you) to true.

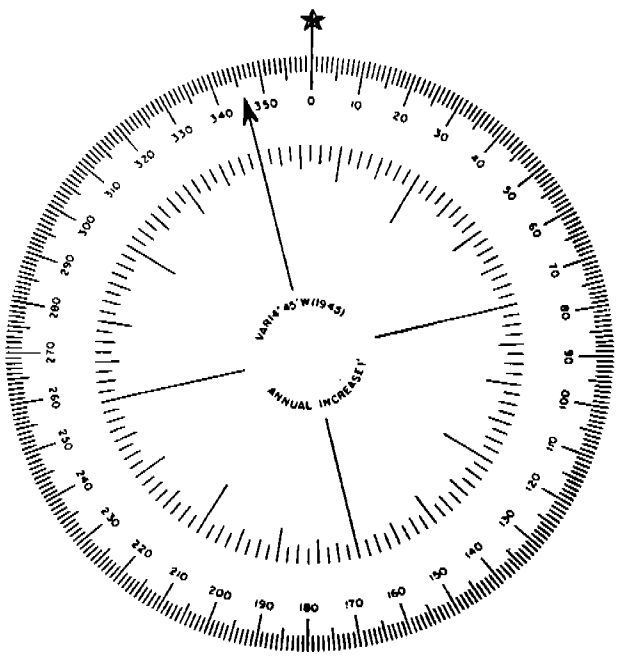


Figure 21.7. The compass roses that appear on nautical charts help the navigator to measure directions on the chart and to determine what the variation is in that part of the world. The star indicates true (geographic) north and the arrowhead is pointing toward magnetic north.

This is accomplished by applying the corrections for variation and deviation and is easier for most people to remember by the use of a nonsensical but effective memory aid. We begin by using certain letters to represent the parts of our calculation as follows:

C = Compass (the actual reading we get off the compass itself)
M = Magnetic (the actual magnetic heading after it has been corrected for deviation)
T = True (the true heading or bearing after all corrections have been applied)
V = Variation (from the compass rose of your chart)
D = Deviation (from the deviation table on your ship)

With these letters in mind, we can use the following memory aid to convert your compass readings to true: *C*an *D*ead *M*en *V*ote *T*wice *A*t *E*lections.

Table 21.1. Deviation table

Ship's Heading (magnetic)	*Deviation*	*Ship's Heading (magnetic)*	*Deviation*
000° (360°)	14°W	180°	13°E
015°	10°W	195°	14°E
030°	5°W	210°	12°E
045°	1°E	225°	9°E
060°	2°E	240°	4°E
075°	5°E	255°	1°W
090°	7°E	270°	7°W
105°	9°E	285°	12°W
120°	15°E	300°	15°W
135°	16°E	315°	19°W
150°	12°E	330°	19°W
165°	12°E	345°	17°W

Even though this phrase makes little sense, it has helped mariners remember how to convert their compass headings and bearings to true for centuries. What it tells us is to start with the reading on your *c*ompass (*C*an). Apply the correction for *d*eviation (*D*ead) to get the *m*agnetic (*M*en) heading. Then apply *v*ariation (*V*ote) to get your *t*rue (*T*wice) heading. The last part, *A*t *E*lections, tells you that you should *a*dd *e*ast, which means that all easterly corrections should be added (and, conversely, all westerly corrections should be subtracted).

For example, if your compass is telling you that your ship is heading due east (090°) and you know from your deviation table that your correction should be 7°E, you would *add* 7 to 090 and find your magnetic heading to be 097°. If the compass rose on your chart told you that the magnetic variation for the part of the world covered by your chart is 4°W, you would then subtract 4 from 097 to get your true heading of 093°.

Sometimes, you will want to reverse the process, converting true headings or bearings to those you would expect to see on your magnetic compass. Some Sailors prefer to just use the "Can Dead Men Vote Twice At Elections" memory aid in reverse. But this can get a little confusing as to when to add or subtract, so others use "*T*imely *V*essels *M*ake *D*istance *C*ount *A*t *W*ar" to remember this process. Still others make up their own memory aids.

Gyrocompass

This compass does not rely on the magnetic properties of the earth. Instead, it uses a heavy flywheel driven at high speed by an electric motor mounted on gimbals that free it to move in all directions. This mechanism allows the flywheel to remain more or less suspended in space, oriented with the axis of the spinning earth and, therefore, pointing toward true north.

The gyrocompass (often called simply "gyro") itself is usually located in a well-protected place below deck, but one of the advantages of this compass is that other compass cards that are electrically connected to the main gyro, called *repeaters,* can be placed on the bridge and in other parts of the ship, wherever they are needed. These repeaters show the same readings as the master gyrocompass and allow you to have many compasses from just one.

Gyro Error. The gyrocompass is not affected by variation or deviation. The motion of the earth causes the rotor to move so that its axis lies in a north-south direction. However, for mechanical reasons and because of the ship's vibrations, even the best gyrocompass will sometimes vary from true north. This gyro error is rarely more than a few degrees—often it is a half-degree or less—and normally it is constant over a long period of time and is not dependent on the heading of the ship.

Gyro error is determined at sea by shooting an azimuth (roughly equivalent to taking a bearing) to a celestial body where the exact bearing can be determined. In port or within sight of land, the error may be determined by sighting on two objects that are in line and their true bearing can be determined from a chart. This error is applied every time the compass is used, and the rule for these corrections is easy to remember if you use the word "GET" as a memory aid. Making a simple equation out of the word ($G + E = T$) will tell you that to go from *g*yro to *t*rue, you must add your *e*asterly error. For example, suppose you use your gyro to sight a church steeple and a watertower that are in a line, and the bearing you read is 277°, but a line drawn between the two on a chart indicates that the true bearing is actually 278°. You know that 277 + 1 = 278, so you have a gyro error of 1°E. This means that all bearings taken by gyrocompass should have one degree added to them to get their actual true bearing for plotting on your chart.

Electronic Navigational Equipment

A variety of electronic systems are used by mariners to help them navigate. Some, such as LORAN and GPS, are specially designed

as navigational systems that have transmitting stations on the earth or in orbit as satellites. Others, such as radar and sonar, are self-contained within the ship and do not have to rely on external stations.

Radar, originally developed as a means for detecting and approaching targets in warfare, has since evolved into a valuable electronic navigational aid. As a self-contained system it does not require external transmitting stations to be effective as a navigational tool. It is best suited for taking ranges, although it can be used (with caution) as a means of obtaining a bearing as well.

Sonar may also be used on a limited basis as a navigational tool. Designed primarily as a kind of underwater radar, using sound waves instead of radio waves to detect targets underwater, sonar can be used in conjunction with underwater topographical charts to determine one's position.

A device specifically designed for navigational purposes that is a kind of simplified sonar set is the *fathometer*. By sending a sound wave straight down beneath the keel of the ship and measuring the time required for it to return, you can determine the depth of the water.

Chronometers

The accurate measurement of time is critical to the success of the navigator. A simple clock is not normally accurate enough for navigational purposes, so navigators rely on a special device called a *chronometer*. Mounted in a brass case, which is in turn supported in gimbals in a wooden case to counteract the ship's motion, chronometers are kept in a cabinet in the chart room, usually on the ship's centerline, where they are protected against shock and temperature changes. A good chronometer never deviates more than a hundredth of a second from its average daily rate.

Chronometers are set to show Greenwich Mean Time and are wound every day at exactly the same time. Once a chronometer is started, it is never allowed to stop, and it is not reset while aboard ship. Chronometers are checked against radio time signals, or GPS readings, fast or slow.

Visual Equipment

A lot of navigating is done with the eye. Visual bearings are a key part of piloting, and observations of the heavenly bodies are an essential part of celestial navigation. A number of devices have been created to enhance the power of the eye and aid in its precision.

Bearing Circle

This ring is placed over a compass and is equipped with sighting vanes (similar to the gunsight on a rifle) which, when lined up on an object, permits you to read that object's bearing from you. When you are told to "shoot a bearing" or "take a bearing" to an object, this simple device will aid you in doing so.

Azimuth Circle

Similar to a bearing circle, this is also a ring that is placed over a compass, but it has some extra attachments that will help you make a visual sighting on a celestial body. Determining the direction to a star, a planet, the sun, or the moon is an important part of celestial navigation and is useful for other things such as determining your gyrocompass error. When determining the direction of an object on the earth, you obtain a *bearing;* when determining the direction of a celestial body, you obtain an *azimuth.*

Telescopic Alidade

This device—often called simply an alidade—is similar to a bearing circle, but has a telescopic device permanently mounted to it so that you can see the objects you are "shooting" more clearly. A cross-hair on the lens improves your accuracy and a mirror device in the telescope allows you to read the bearing off the compass while looking through the scope.

Sextant

The sextant is a precision instrument that can measure angles in degrees, minutes, and seconds. In its most common use, the sextant takes the image of a star (or other celestial body) and, through a mirror system, makes the star look like it has been moved from up in the sky down to rest on the horizon. Having done this, the precision scales on the sextant allow the navigator to read the exact angle between the actual star and the horizon. This angle, called the altitude, is the basic measurement in celestial navigation that will (after a series of calculations) yield an LOP.

The sextant can also be used to measure the angle between two objects on the shore which can be used to help determine your position.

Stadimeter

If you know the height of an object, such as a lighthouse, a watertower, or the mast of another Navy ship, the stadimeter can be used to measure its distance from you. It is effective for heights between

50 and 200 feet, and at distances of 200 to 10,000 yards. Like a sextant, the stadimeter measures angles, but it accomplishes this a little differently. By setting the height of an object on an adjustable scale, you then look through the stadimeter to make a reflected image of your "target" coincide with the actual direct image. The distance is then read from another scale.

Lookouts

One of the most useful elements of navigation and of safe shiphandling is the lookout. Radars and sonars may fail to detect such things as smoke, small navigational markers, objects close to the ship, flares, or people in the water. These must be reported by the lookouts—the eyes of the ship. Upon their alertness rests much of the safety of the ship and her crew.

You may very well stand lookout watches at some time during your stay in the Navy. As a lookout, you must do much more than keep your eyes open. You must know how to search in a way that will cover every inch of the sector you are assigned, and you must be able to report the location of an object to the OOD in a way that will give her or him the information she or he needs. You must watch for ships, planes, land, rocks, shoals, periscopes, discolored water, buoys, beacons, lighthouses, distress signals, floating objects of all kinds, and anything else unusual. You must not only be the eyes but the *ears* of the ship as well, and report sounds, such as fog horns, ships' bells, whistle buoys, airplanes, surf, and anything unusual. The golden rule of being a good lookout is "If in doubt, report it." It is better to give the OOD too much information than to miss the one critical piece of information that can put the ship in jeopardy.

How many lookouts a ship will have at any given time depends upon the size and type of the ship and the conditions in which she is operating. Small ships will usually have only three lookouts: two in the vicinity of the bridge (port and starboard) and one after lookout somewhere astern. Larger ships may have more lookouts assigned to provide additional coverage. Each is stationed where he or she can best cover the surface and sky within his or her assigned zone. If lookouts are stationed any distance away from the OOD, they will wear sound-powered phones so that they may expeditiously send reports. It is good practice for a lookout to only use one of the earphones on the sound-powered set so that the free ear can be used to listen for relevant sounds as described above.

Low-visibility lookouts. In fog or bad weather, additional lookouts are stationed immediately in the eyes of the ship (as far forward as

practical) and on the bridge wings. Sound carries much farther in fog than on clear days, so a lookout must listen closely—especially if he or she is located in the bow—for whistles, bells, buoys, and even the wash of water against the ship's stem. For this reason, fog lookouts do not wear sound-powered phones. Another Sailor is assigned to man the phones at each fog lookout station to make reports to the OOD.

Night vision. If you were to go on night watch directly from a lighted compartment, you would be almost blind for a while. As your eyes become accustomed to the weak light, your vision gradually improves. After 10 minutes you can see fairly well, and after 30 minutes you have your best night vision. This improvement is called dark adaptation.

Obviously, it is unsatisfactory to have someone standing a lookout watch who does not have 100 percent vision. To prevent this lost time while your eyes are adjusting to the dark, you must be sure that your eyes are not exposed to any white light (such as everyday light bulbs and fluorescent tubes) before going on watch. Fortunately, the human eye's ability to see in the dark is not affected by red light. That is why you will see only red lights on after dark in berthing compartments and at the various watchstations. Even with these precautions, there are places in the ship where you might encounter white light, such as on the mess decks where you might want to go get a sandwich or a cup of coffee before going on watch. To protect your eyes from any unwanted exposure to white light, you must put on specially designed red goggles before going on night lookout duty at least a half-hour before you must report for your watch. Be sure to leave them on for the full 30 minutes. These goggles prepare your eyes for darkness without affecting your ability to go about normal prewatch activities such as writing letters, watching television, or getting dressed and ready for your watch. Even with this precaution, you should still give yourself an additional five minutes of adjusting to the outside conditions before actually assuming the watch. As you know, it will probably take longer than that to get a full report from the person you are preparing to relieve.

Once you have assumed the lookout watch at night, you must learn to use your "night eyes" effectively. Because of the way your eyes are made—the light receptors for white (daytime) light are in the center of your eye, while your night-vision receptors are located around the daylight ones, off center—you normally look directly at an object to see it best in the daylight, but in the dark you should look to one side of an object to see it best. This will take some practice, but once you get used to it, you will be amazed at how well it works.

At night, it is easier to locate a moving object than a stationary one. But most objects in or on the water move relatively slowly. To counter this, move your eyes instead. This technique will significantly enhance your ability to pick up targets in the night. Slowly scan the area in broad sweeps instead of stopping to search a section at a time. If you think you see something while scanning, avoid the natural tendency to look right at it. Use the off-center technique to confirm the sighting and then report it.

Binoculars. Contrary to widespread belief, it is not always better to search with binoculars. Several factors govern when and how they should be used. In fog, for instance, they should not be used at all. At night, however, they will enhance your vision and should be used often.

Keep in mind that while they significantly magnify, binoculars' field of view is only about 7 degrees, which is pretty narrow. This means you can see objects at considerably greater distances than with the naked eye, but you are able to view only a very small portion of your assigned sector while looking through them. To counter this limitation, you should use the *scanning technique* when using binoculars to search for targets. This is a step-by-step method of looking. To understand this technique, try moving your eyes around a room or across the horizon rapidly and note that as long as your eyes are in motion, you see almost nothing. (You may have noticed this if you ever saw a video shot by someone who was moving the camera too rapidly—everything is a blur.) Now allow your eyes to move in short steps from object to object. You will be able to see what is there. When searching a seemingly empty stretch of sea, make yourself search your sector in short steps (approximately 5 degrees at a time), pausing between steps for approximately five seconds to scan the field of view. At the end of your sector, lower the glasses and rest

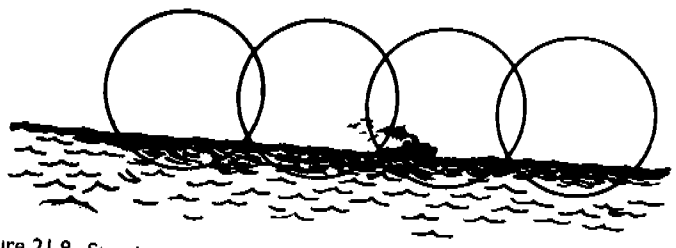


Figure 21.8. Step-by-step scanning.

your eyes for a few seconds, then search the sector in the reverse direction with the naked eye.

A sky lookout searches from the horizon to the zenith (overhead), using binoculars only to identify a contact. Move your eyes in quick steps—also about 5 degrees—across your sector just above the horizon, shift your gaze up about 10 degrees, and search back to the starting point. Repeat this process until the zenith is reached (you are looking straight up), then rest your eyes for a few seconds before starting over.

Reports. Every object sighted should be immediately reported to the OOD, no matter how insignificant it may seem to you. The report consists of two basic parts: what you see, and its bearing (direction) from the ship. Aircraft sighting reports also include altitude (called position angle).

Because they do not always have access to a compass at their watchstation, lookouts report objects in degrees of *relative bearing.* You will remember that navigational directions are described by true bearings where 000° represents true north, 090° is east, and so on. Relative bearings are similar to true bearings except that they are ori-

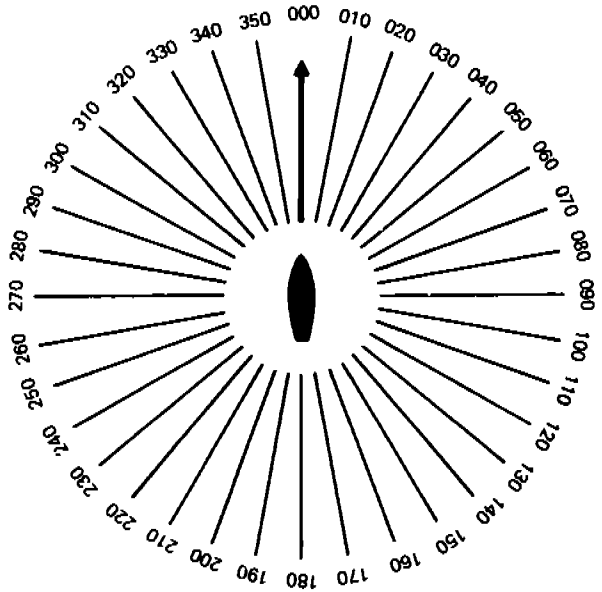


Figure 21.9. Relative bearings are measured clockwise from the ship's head and locate an object in relation to the ship. They have nothing to do with geographical directions.

ented on the ship's bow instead of true north. Therefore, 000° represents the ship's bow when using relative bearings. Just as true bearings progress in a clockwise direction, so do relative bearings. If you want to report a periscope that is broad on the ship's starboard side, its relative bearing is 090°. A fishing boat dead astern would be reported as 180°R, and a buoy approximately halfway between would be 135°R.

Bearings are always reported in three digits and spoken digit by digit. For example, you would report a merchant ship broad on your port side as "two-seven-zero degrees relative."

An object in the sky is located by its relative bearing and position angle. The position angle of an aircraft is its height in degrees above the horizon, as seen from the ship. The horizon is considered to be zero degrees and directly overhead is 90 degrees. Position angles can never be more than 90 degrees, and they are given in one or two digits and spoken as a whole number, not digit by digit. The words "position angle" are always spoken before the numerals. Thus, if you spot an aircraft flying just a little above the horizon halfway between the bow and the starboard side of your ship, you would report it as

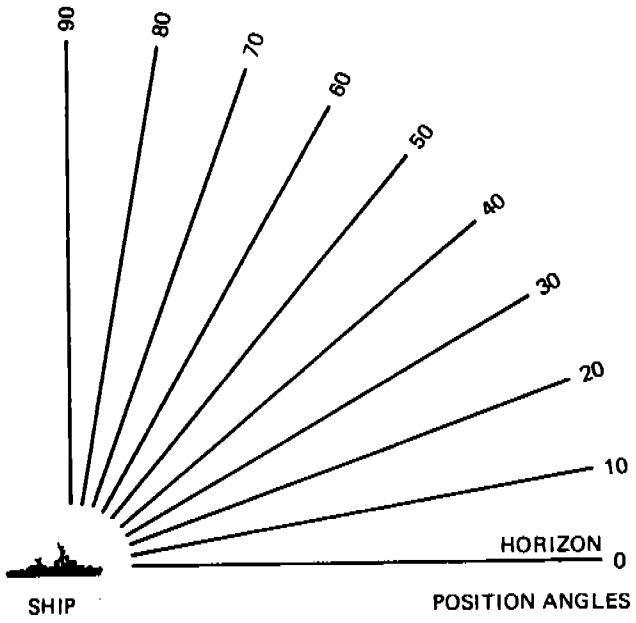


Figure 21.10. Position angles locate an object in the sky.

"zero-four-five degrees relative, position angle ten." A helicopter hovering dead astern of your ship, about two-thirds of the way between the horizon and straight up, would be reported as "one-eight-zero degrees relative, position angle sixty."

Plotting Instruments

Once information, such as bearings or ranges, has been obtained using the navigational equipment described above, it must be plotted on a chart to be of use to the navigator. A number of instruments have been developed—some of them centuries old—to aid the navigator in this process.

Compasses and Dividers

Somewhat confusing is the fact that one of the instruments used by the navigator has the same name as one of the major pieces of equipment also used in navigation—the compass. You probably are familiar with *this* compass from your math classes in school. It is a pencil point and a sharp metal point joined in such a way as to facilitate the drawing of circles and arcs. This instrument is particularly useful for plotting ranges on charts.

A pair of dividers is much like a compass except that both points are sharp metal ones. This instrument is primarily used to measure distances on charts.

Parallel Rulers

The name of this instrument describes it well. Two straight-edged rulers are joined by hinged arms that allow a direction to be moved across a chart by "walking" the rulers, such as when the navigator wants to move a bearing line across the chart to measure its direction on the compass rose.

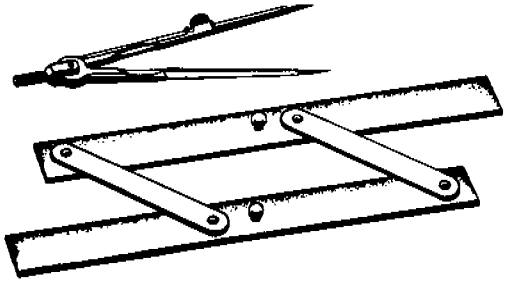


Figure 21.11. Dividers and parallel rulers.

Parallel Motion Protractor

Also called a universal drafting machine, this instrument is clamped to a chart table and aligned with the chart so that both distance and direction may be plotted at once. It is a fast and efficient means of plotting. The parallel motion protractor (often simply called a PMP) provides a very reliable method for plotting direction because, once aligned and set, there is little chance for it to slip as can happen with parallel rulers. This device, in essence, provides a movable compass rose that can be moved all over the chart with ease.

Nautical Slide Rule

This circular device simplifies time, distance, and speed calculations. By entering two known variables (such as distance and speed) on the appropriate scales, you can read the third (such as time) as needed.

Navigational Publications

Many publications are available which provide the information a navigator can use to better navigate his or her vessel. Nautical charts are printed and updated by the National Ocean Service (NOS) and the National Imagery and Mapping Agency (NIMA).

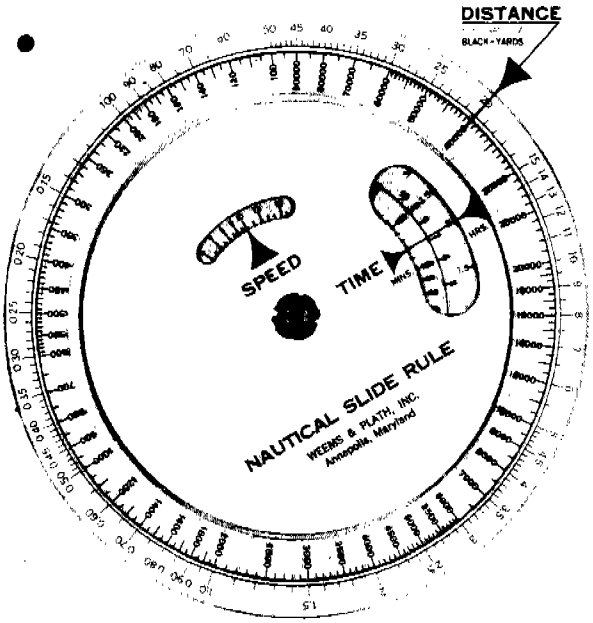


Figure 21.12. A nautical slide rule.

Additional valuable information about the various navigational aids found on these charts and supplementary information about what you can expect to find in the various waterways of the world is found in several important publications. For American waters, valuable supplementary information is contained in two publications: *Light Lists*, published by the U.S. Coast Guard, and *Coast Pilots*, published by NOS. For the other waters of the world, you must use the NIMA's *List of Lights* and *Sailing Directions* to obtain similar help.

NIMA also publishes useful information for U.S. Navy vessels in publications called *Fleet Guides*. These not only contain useful navigational information, but administrative and logistical data as well.

Tide Tables, which predict the height of the tide at given times, and *Tidal Current Tables*, which predict the direction and velocity of the currents associated with tidal variation at given times, are essential to the navigator.

Prepared jointly by the U.S. Naval Observatory in Washington, D.C., and the Royal Greenwich Observatory in England but published in the United States by the Government Printing Office, *The Nautical Almanac* (published once a year) and *The Air Almanac* (published twice a year) provide a wealth of data about the precise times and positions of celestial bodies as they rise, travel across the sky, and set.

Another set of publications used for celestial navigation is the *Sight Reduction Tables for Marine Navigation*, published by NIMA.

Various other publications are useful to the navigator, such as *Tables of Distances between Ports* (NIMA), *Tables of Distances between United States Ports* (NOS), *Handbook of Magnetic Compass Adjustment* (NIMA), and the *Radar Navigation Manual* (NIMA).

For those who want to become skilled navigators, much more detailed information about the art and science of navigation can be found in the NIMA publication, *American Practical Navigator* (also called "Bowditch" after its original author), and the following books, published by the Naval Institute Press: *Dutton's Navigation* and *Marine Navigation* by Richard R. Hobbs. Many other commercially produced publications can be useful to the serious student of navigation.

Tides, Currents, and Winds

Despite all of the advances of modern technology, ships are still very much subject to the natural forces at sea and in coastal waters. Anyone who ventures onto the great waters of the world must do so with an understanding that tides, currents, and winds will have an effect on

what they do. Whether you are piloting a small boat on a narrow waterway or are part of the team that turns an aircraft carrier into the wind to launch aircraft, the more you understand about how these forces work and what their effects will be, the better mariner you will be.

Tides

Tides are very important in naval operations. Amphibious landings are normally scheduled for high tide so that troops and equipment can land well up on a beach. In some harbors, deep-draft ships may be able to enter only at high tide. Large ships are usually launched or dry-docked at high tide. Ships going alongside piers in channels subject to strong tides and currents normally wait for slack water, when the tide is neither ebbing nor flooding. Every Sailor whose responsibility is the handling of a vessel must understand the meaning and cause of various tidal conditions.

The term *tide* describes the regular rise and fall of the water level along a coast or in a port. The gravitational attraction of the moon is the primary cause of tides; it pulls water away from the earth. The earth's spinning motion also causes a bulge of water on the side of the earth opposite to the moon. Since the moon orbits the earth every 24 hours and 50 minutes, the result of these forces causes two low and two high tides at any given place during that period. The low and high tides are each 12 hours and 25 minutes apart. The sun also affects the tide, but it is so much farther away than the moon that its pull is not nearly as great. It does, however, have an effect such that the rise and fall of tides are more complicated than they would otherwise be. Despite these variables, tides can be predicted with relative certainty and the successful mariner will take advantage of this predictability whenever possible.

A tide rising or moving from low to high water is said to be *flooding*. When the tide is falling, after high tide, it is said to be *ebbing*. The difference in depth between a high tide and the next low tide is considerable in many harbors; areas that are safe for a powerboat at high tide may be completely dry at low water. In some areas of the world, you might board a vessel from a pier in the morning by stepping directly across, using a level brow, and that same afternoon, you would have to use a ladder to climb up to the main deck.

Currents

In most harbors and inlets, tides are the chief causes of currents; however, if the port is situated on a large river, its flow may also have a

marked effect on tidal currents. The flow of a large river will prolong the duration of an ebbing current, and the velocity of that current will be considerably greater than that of the floodtide caused by effects of the moon and sun.

Where currents are chiefly caused by the rise and fall of the tide, their direction and speed are largely governed by the shape of the shoreline and the contour of the ocean bottom. In a straight section of confined waterway, the current tends to flow most rapidly in the center and much more slowly in the shallower water near either shore. If a boat goes with the current, the coxswain generally wants to stay near the center of the waterway. If a boat goes against the current, the coxswain stays as close to shore as the prevailing water depth will allow.

In many wide inlets, near the time of slack water the current may actually reverse itself in part of the inlet; while the ebb is still moving out of the main channel, a gentle flood may start near one shore. This condition, where it exists and is understood, can be helpful to a small-boat operator.

Where there is a bend in the channel, the current flows most strongly on the outside of the bend. This effect is very marked, particularly with a strong current. In some areas, a strong current can create rough water called tide rips. These are usually shown on charts and should be avoided. Every vessel, regardless of size, must make some allowance for the current's *set* and *drift* (direction and speed), which affects the course to be steered.

One more thing to bear in mind about currents: only on the coast does the turn of the current occur at the time of high water. In many ports, owing to the effect of the land's shape on water flow, there may be a very considerable difference between the time of high (or low) water and the time that the current starts to ebb (or flood).

Winds

Modern naval vessels are not dependent on the wind for power, as sailing ships were, but at times the wind's effect on a ship can be considerable. Although sails are no longer used on naval vessels, the area of the ship's hull and superstructure exposed to the wind is still called *sail area*. The more sail area a ship has, the more effect wind has on it. For example, an aircraft carrier, with all of its massive sail area, will have a more difficult time moving into a pier that has an offsetting wind blowing than will a submarine, which is low to the water and has much less area exposed to the effects of the wind.

The natural wind that is blowing at any given time (the breeze you feel on your face, for example, when you are standing on a beach looking out to sea) is called *true wind.* You know that on a perfectly still day, when there is no wind blowing, you can easily have your cap blown off while riding in a convertible with the top down. This air flow, caused by the vehicle moving through the air, is called *relative wind* (its velocity is directly *relative* to the speed you are traveling). When the effect of these two are combined, it is called *apparent wind.* For example, there will seem to be a lot more wind blowing if you drive down a road at high speed *into* the wind.

To illustrate these various winds, think about traveling in a small boat at a speed of 20 knots. If, when you start out, there is no (true) wind blowing, the relative wind (caused by your motion) will be 20 knots. An hour later, the wind has begun blowing out of the north at a speed of 10 knots. If you head north, the apparent wind will be 30 knots (20 relative + 10 true). If you head south, the apparent wind will be 10 knots (20 true – 10 relative). If you head in any other direction the apparent wind will be something in between 10 and 20 knots depending upon the course chosen.

The effect of wind on ship operations can be beneficial or detrimental. During flight operations, an aircraft carrier most often steams into the wind, because the increased speed of the apparent wind helps aircraft take off and land by providing them more lift. A strong wind can make mooring a ship more difficult by keeping it off the pier or causing it to blow down on the pier too quickly.

At sea, the direction of the true wind is indicated by streaks of foam down the back sides of waves, while the direction of the apparent wind is shown by the way the ship's flags are blowing. True winds are described by the direction *from* which they are blowing. A north wind is blowing from the north toward the south, for example.

The side of the ship toward the wind is the *windward* side, and the side away from the wind is the *leeward* side. When the wind changes direction to the right, or clockwise, it *veers;* when it changes in the other direction (counterclockwise), it *backs.*

The Beaufort Scale

Devised to help mariners describe wind and sea conditions, the Beaufort scale provides a guide that helps you equate what you are seeing with a range of wind speed. Study the scale below and you will be able to make assessments of the weather without the aid of instruments.

Table 21.2. The Beaufort Scale

Beaufort Number	*Wind speed (knots)*	*Seaman's Term*	*Appearance of Sea*
0	Below 1	Calm	Surface like a mirror
1	1–3	Light air	Ripples that look like fish scales, but without foam crests
2	4–6	Light breeze	Small wavelets, still short but more pronounced; crests look glassy and do not break
3	7–10	Gentle breeze	Large wavelets; crests begin to break; glassy-looking foam; perhaps scattered whitecaps
4	11–16	Moderate breeze	Small waves; becoming longer; fairly frequent whitecaps
5	17–21	Fresh breeze	Moderate waves, taking a more pronounced long form; many whitecaps are formed; chance of some spray
6	22–27	Strong breeze	Large waves begin to form; white foam crests are more extensive everywhere; probably some spray
7	28–33	Moderate gale (high wind)	Sea heaps up and white foam from breaking waves begins to move in streaks in the direction of the wind
8	34–40	Fresh gale	Moderately high waves of greater length; edges of crests break into spindrift; foam is blown in well-marked streaks in the direction of wind
9	41–47	Strong gale	High waves; dense streaks of foam in the direction of wind; sea begins to roll; spray may affect visibility
10	48–55	Whole gale	Very high waves with long overhanging crests; resulting foam is blown in great patches of dense white streaks in the direction of wind; whole surface of the sea looks white; rolling of the sea becomes heavy and shocklike; visibility is affected

11	56–63	Storm	Exceptionally high waves; small and medium-sized ships might be lost to view behind the waves; sea is completely covered with long white patches of foam lying in the direction of wind; everywhere the edges of wave crests are blown into froth; visibility is seriously affected
12	64–71	Hurricane	Air is filled with foam and spray; sea completely white with driving spray; visibility very seriously affected

Communications

22

Communications is a vital part of the Navy. Ships must be able to communicate with each other when operating together, aircraft must be able to talk to one another and to the ships they are operating with, and fleet commanders must be able to report to and receive instructions from Washington, D.C. These are all forms of *external* communications and are extremely important. But just as important, the various stations within a ship must be able to communicate with one another—called *internal communications*. For example, the ship's damage-control parties must be able to communicate with DCC and the bridge during an emergency, the bow lookouts must be able to report to the OOD what they see and hear, and Primary Flight Control on an aircraft carrier must be able to communicate with Sailors moving aircraft about on the flight deck.

Internal Communications

Probably the oldest form of internal communications—the messenger—is still among the most reliable. Modern ships have other means available which are much faster than sending a runner. Simple buzzer and light signals are used to attract attention when needed and to provide basic information about the current status of a system or component. Such things as rudder-angle indicators and engine-order telegraphs are more elaborate means of communicating equipment status. Computer links are used for sophisticated systems information, and synchro- and servo-systems are used with weapons systems to convey important information. Larger ships have telephone systems similar to the ones you have used all your life. The ship's bell is also used to convey information to the crew, and even the "aboard/ashore board" used on the quarterdecks of many ships to indicate who is aboard at any given time is a means of internal communications.

The two most widely used forms of internal communications are the *MC* and *J* systems. MC systems include one-way loudspeaker systems and special box systems that allow various stations to talk

back and forth to each other. J systems are the Navy's sound-powered phone systems that have the advantage of not requiring electrical power to function.

MC Systems

The chief advantage of these systems is that they electrically amplify the human voice so that it can be heard by many people at one time and in noisy conditions. Their major disadvantages are that they cannot be depended upon if electrical power is lost and they add noise to an already noisy environment. Some of the MC systems are what you might call public-address systems. The Navy calls them central-amplifier systems. They use a system of speakers (located where needed) to broadcast information, but the receiving stations cannot answer back. Other MC systems are made up of two-way boxes in different locations around the ship which are wired to each other in such a way that the stations can talk to each other, either all at the same time or only one or a few at a time. These boxes are equipped with buttons that can be pressed so that only certain stations will hear what is being said. If you want to talk to all the stations on the circuit at the same time, push all of the buttons, but if only three of the stations on the circuit need the information you want to pass, you can press just the three buttons to those stations and not bother the others.

The 1MC System

In the old Navy, before the days of loudspeaker systems, the boatswain's mate passed any orders for the crew by word of mouth. The boatswain's mate of the watch (BMOW) sounded "Call mates" on his pipe to get the other boatswain's mates together, and they converged on the quarterdeck while answering repeatedly with the same call on their pipes. Upon hearing the word, they dispersed throughout the ship to sing it out at every hatch.

While this procedure was colorful, it took a lot of time. Today a single boatswain's mate can quickly pass the word over the MC circuit to reach all or part of the ship at one time.

The ship's general announcing system, over which the word can be passed to every space in the ship, is designated the 1MC system. Transmitters are located on the bridge and quarterdeck so that the word can be passed by the OOD at sea and in port.

On some ships an announcement is preceded by a boatswain's call or pipe to get the attention of the crew. A special call, called "All hands," is piped before any particularly important word, and a shorter call, called "Attention," is used before more routine announcements.

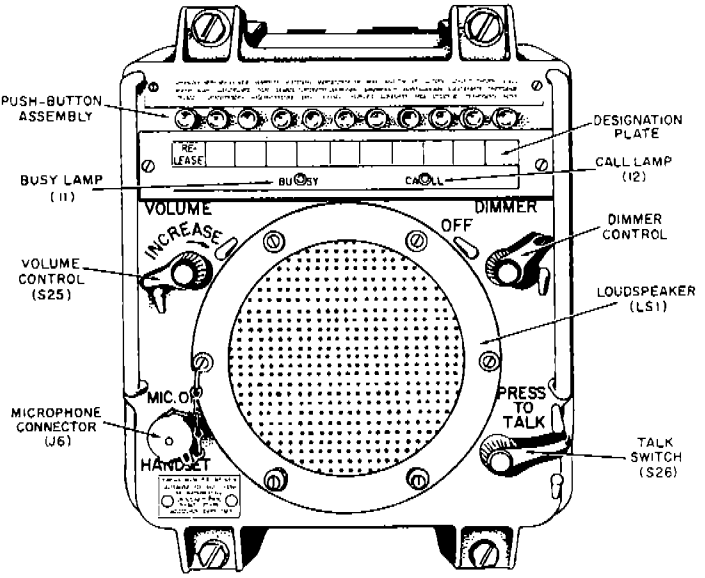


Figure 22.1. A two-way MC unit.

You will hear many different kinds of announcements over the 1MC. For most, the meanings will be obvious, but others will take some getting used to. Listed below are some of the more common announcements heard over the 1MC, followed by a brief explanation. The words used here are typical but may differ somewhat from ship to ship.

"Air bedding." Mattresses and pillows are to be removed from your rack and taken topside where they should be draped over the ship's rail for a few hours to air out.

"Haul over all hatch hoods and gun covers." A rain squall is approaching. All open hatches must be closed and protective tarps must be rigged.

"Mail call." Incoming mail is available for pickup.

"Mess Gear. Clear the mess decks." All personnel not assigned as mess cooks or attendants should leave the mess decks area so that preparations can be made for the next meal.

"The OOD is shifting his [her] watch from the bridge to the quarterdeck." This announcement alerts the crew that the OOD can now be found on the quarterdeck instead of the bridge. This occurs when the ship enters port. When the ship gets underway the opposite

announcement would be made (*"The OOD is shifting her [his] watch from the quarterdeck to the bridge."*)

"Reveille, reveille. All hands heave out and trice up." It's time to wake up and get out of your rack (bunk).

"Taps, lights out. All hands turn in to your bunks and keep silence about the decks." It is time to go to bed. If you are not going to bed at this time, you must be as quiet as possible when in the vicinity of berthing compartments.

"Turn to. Commence ship's work." Passed in the morning to announce the beginning of the work day. After the noon meal, a slightly modified version (*"Turn to. Continue ship's work."*) is passed.

"Up all late bunks." All personnel who have been sleeping in (beyond reveille) because they had the mid-watch the night before must now wake up.

The OOD is in charge of the 1MC. No call can be passed over it unless it is authorized by the OOD, the executive officer, or the captain.

Normally, the 1MC is equipped with switches that make it possible for certain spaces to be cut off from announcements of no concern to them. The captain, for instance, does not need to hear the call for late bunks, so his or her cabin can be cut out of the announcement.

Other MC Systems

Many MC systems are available for shipboard use, but not all of them will be found on every ship. They are listed below. (*Note:* Those systems with an asterisk are central amplifier [one-way] systems; the others are all two-way networks.)

*1MC	General
*2MC	Propulsion plant
*3MC	Aviators
4MC	Damage control
*5MC	Flight deck
*6MC	Intership
7MC	Submarine control
8MC	Troop administration and control
*9MC	Underwater troop communication
18MC	Bridge
19MC	Aviation control
21MC	Captain's command
22MC	Electronic control
23MC	Electrical control

24MC	Flag command
26MC	Machinery control
27MC	Sonar and radar control
*29MC	Sonar control and information
30MC	Special weapons
31MC	Escape trunk
32MC	Weapons control
35MC	Launcher captains
39MC	Cargo handling
40MC	Flag administrative
42MC	CIC coordinating
44MC	Instrumentation space
45MC	Research operations
*46MC	Aviation ordnance and missile handling
47MC	Torpedo control
50MC	Integrated operational intelligence center
51MC	Aircraft maintenance and handling control
53MC	Ship administrative
54MC	Repair officer's control
55MC	Sonar service
58MC	Hangar-deck damage control
59MC	SAMID alert

Sound-Powered Telephones

In battle conditions or during other emergencies, a ship may lose some or all of its electrical power. Battery-powered communication systems are good only as long the batteries hold out, and radio systems (such as walkie-talkies) are not always effective through steel bulkheads and decks (and they put radio signals into the air that can be detected by enemy forces in the vicinity). Because of these potential problems, ships must have some means of communicating internally that does not require an outside source of electrical power to function. For many decades, the Navy has relied upon a relatively simple but very reliable invention called the sound-powered telephone, which relies upon the energy generated by the user's voice to create enough current to power the circuit.

You will probably stand some sort of watch aboard ship that will require you to use a sound-powered telephone system. A ship at sea requires many talkers, even during a peacetime cruising watch. In addition to the lookouts, there are talkers on the bridge, in CIC, and in enginerooms, to mention only a few. These phones are used on all ships, and some ships have hundreds of them. To do your job

properly, you must have a basic understanding of the ship's sound-powered system and you must learn proper telephone-talking procedures.

Ship's Sound-Powered System

For many years, sound-powered circuits were a primary source of interior communications. In ships with the newer IVCS system [see below], sound powered systems are now secondary.

Sound-powered systems are recognizable as such by the letter *J* in their circuit designation. Different circuits connect different parts of the ship for different purposes. An additional letter after the *J* represents the general purpose. For example, the letter *S* after the *J* in a circuit identifies that circuit as one used to gather sensor information (such as radar or sonar), the letter *L* would be used by lookouts to pass information to the bridge, CIC, and other stations that may need it, and so on.

As a further means of identification, numbers may precede the *J* to differentiate different circuits of the same general type. For example, on a ship that has only one primary weapons system, the circuit connecting key weapons stations would be simply designated the JC circuit. But on a ship with two major weapons systems, there would be two separate circuits, designated 1JC and 2JC. On most ships, the surface-search radar circuit is designated the 21JS while the air-search radar circuit is designated the 22JS.

Vital circuits are duplicated by what are called *auxiliary circuits*. Even though these circuits connect the same stations as the primary circuit, the wires connecting them are deliberately run through different parts of the ship so that damage to one is less likely to result in simultaneous damage to the other.

There are also some additional special circuits called *supplementary circuits,* which are short, direct lines used to connect key stations that need a source of quick, reliable communications, such as between the captain's sea cabin and the bridge. Because supplementary circuits are not manned, most of these circuits contain a buzzer system so that one station can alert another that communications between the two are desired.

The letter *X* precedes both auxiliary circuits and supplementary circuits, but you can tell the difference because the latter do not have an additional letter after the *J*. For example, the XJL and X22JS circuits are alternates of the JL and 22JS primary circuits, while the X1J and X8J would be supplementary circuits.

One last thing you should know about the numbers and letters assigned to sound-powered circuits is that individual stations on a circuit are distinguished from each other by the addition of yet another number at the end of the sequence. For example, 22JS7 identifies outlet number 7 on the 22JS circuit. Other outlets on the same circuit would be assigned individual numbers like 22JS6 and 22JS8, and so on.

Some of the more common sound-powered circuits you may encounter aboard ship are listed below.

JA	Captain's battle circuit
JC	Weapons control
JL	Lookouts
JW	Navigation
JX	Communications
1JV	Maneuvering and docking
21JS	Surface search and radar
22JS	Air-search radar
61JS	Sonar information
2JZ	Damage control

These circuits, and others like them, are manned when necessary but will remain unused at other times. For example, the JL circuit will be manned at all times while at sea but is unused when the ship is moored to a pier.

It is a good idea to familiarize yourself with the available jackboxes (outlets) in your work or watchstation area. That way, if something happens to a circuit you are assigned to talk on, you will know what alternatives are available. For example, if you are assigned as a talker on the JA circuit during GQ and that circuit sustains battle damage, you will save valuable time if you know where any nearby XJA outlets are. Knowing other circuits in your area may prove useful as well.

Some sound-powered circuits, particularly the supplementary ones, have a handset similar to a normal telephone handset that is always attached. These handsets will have a button that must be held down while talking, and they are often accompanied by a buzzer system that will alert you that someone wants to talk to you on that circuit.

Far more common, however, is the sound-powered telephone talker headset that is plugged into a sound-powered circuit outlet and worn by an individual who is specifically assigned as a talker on that circuit when needed.

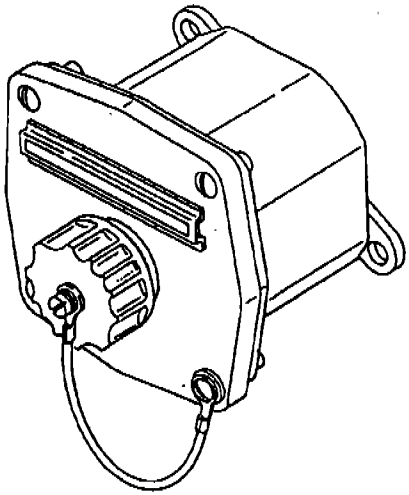


Figure 22.2. A sound-powered telephone jackbox.

Use of the Sound-Powered Headset

The typical headset used with the sound-powered phone consists of a headband that holds the receivers over the ears, a breastplate supported by a cloth neck strap, and a yoke that holds the mouthpiece transmitter in front of the mouth. The phone has a wire lead, which may be up to 50 feet long, with a jack on the end. The jack plugs into a box connected to the circuit.

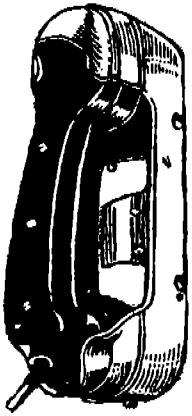


Figure 22.3. Sound-powered handset.

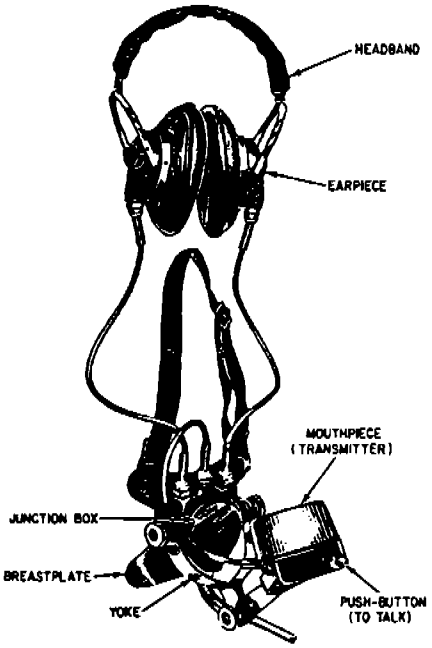


Figure 22.4. Sound-powered headset.

To put the gear on, first unhook the right side of the neck strap from the breastplate, pass the strap around your neck and rehook it. Next, put on the earphones and adjust the headband so that the center of one or both earpieces are directly over your ear(s). In most cases, you will want to keep one ear uncovered so that you can hear what is going on around you. Keep the unused earpiece flat against the side of your head to keep unwanted noises from being picked up. Adjust the mouthpiece so that it is about an inch in front of your mouth. In making this adjustment, remember that the fine wire that goes to the transmitter can be broken if mistreated. Be sure that there are no sharp bends in it, and do not allow it to get caught between the transmitter and the yoke that supports it. Last, insert the plug into the jack box and screw the collar on firmly.

When you are wearing the headset, always keep some slack in the lead cord, and be sure it is flat on deck. If you have the cord stretched taut, someone may trip over it and damage the wires, injure him- or herself, or injure you. Do not allow objects to roll over or rest on the cord.

After plugging in the phones, test them with someone on the circuit. If they are not in working order, report that to the person in charge of your station and don a spare set; don't attempt to repair the set yourself.

Never secure the phones until you have permission to do so. When permission is given, do not just remove the phones and leave them. Unless someone is relieving you and takes the phones from you, always make up the phones for proper stowage. Remove the plug from the jack box by holding the plug in one hand and unscrewing the collar with the other. When the collar is detached, grasp the plug and pull it out, lay it carefully on the deck. Immediately screw the cover on the jack box; dust and dirt can cause a short circuit in a box that has been left uncovered. (If you see an uncovered jack box cover it, even though you are not responsible for the carelessness.) Remove the headpiece and hang it over the transmitter yoke. Coil the lead cord, starting from the end at the phone. Coil the lead in a clockwise direction, holding the loops in one hand. The loops should be eight to ten inches across, depending on the size of the space where the phones are stowed. When you are coiling the lead, be careful not to bang the plug against anything.

When the lead is coiled, remove the headpiece from the transmitter yoke and put the headband in the same hand with the coil. Use this same hand to hold the transmitter while you unhook one end of the neck strap from the breastplate. Fold the transmitter yoke flat, being careful not to put a sharp bend in the transmitter cord. Wrap the neck strap around both the coil of wire you created and the headband two or three times and snap the end back on the breastplate, then fold the mouthpiece back up against the junction box. You then have a neat, compact package to be stowed. Put the phones into their box, or hang them on the hook provided. Be careful not to crowd or jam the leads.

One of the advantages of a sound-powered phone set is that in an emergency the earpieces and mouthpieces are interchangeable—you can talk into an earpiece and listen using the mouthpiece if you need to. This advantage is also a disadvantage, because an uncovered earpiece allows unwanted sound into the circuit that can make it difficult for others on the circuit to hear. Headset phones should, therefore, always be unplugged when not in use. If they are left plugged in, the earpieces will pick up noise and carry it into the circuit.

Never place the phones on the deck. Not only may someone step on them, but decks are good conductors of noise, which the phones can pick up.

Sound-Powered Telephone Talking Technique

The way you ordinarily talk is not the way you should talk on a sound-powered telephone. The person on the other end of the line cannot see you, may not know you, and may be unfamiliar with the things you are talking about. When you are functioning as a shipboard sound-powered telephone talker, you must speak clearly, be specific, and act businesslike. Use a strong (not loud), calm voice, and speak slowly, pronouncing each word carefully. Don't mumble, run things together, or talk with gum or other objects in your mouth. Always use standard terms and phraseology, avoiding slang.

Because sound-powered circuits are open to all stations simultaneously, circuit discipline is essential to prevent too much noise and confusion. Send only official messages. Do not engage in idle chitchat. Each phone talker is a key link in the ship's interior communications chain. Unauthorized talking means that the chain is weakened. Don't engage in it, and don't permit others to, either.

Keep the button in the off position except when you are actually talking. Avoid allowing anger, impatience, or excitement to be noticeable in your voice. Be professional. Few things can be as helpful or as reassuring as a calm voice in the middle of a crisis.

Standard Terms and Phraseology. When talking on a sound-powered telephone (or on a radio circuit and even a standard telephone), your voice does not have the same clarity that it does when speaking face to face with someone. That is one of the reasons why the Navy insists upon standardized terminology when communicating. You have already learned that course headings and bearings are always given as three digit numbers (zero-four-five) while position angles are spoken as "forty" or "seventy," for example. Numbers are often spoken individually rather than in the more conventional (but confusing) manner you were used to in civilian life. Because the numbers 5 and 9 sound very much alike on a sound-powered circuit or on a radio, the number "nine" is always pronounced "niner" in the Navy. This will seem strange to you at first, but after a while it will become second nature. Standardization of speech helps the listener to know what is being said by giving additional clues that will help overcome the reduced sound quality in these communication instruments.

One of the most valuable tools in maintaining clarity and avoiding confusion in communications is the use of the phonetic alphabet. *C, D, E, P, V, T,* and *Z* all sound very much alike on a sound-powered phone, for example. By using their phonetic equivalents (Charlie, Delta, Echo, Papa, Victor, Tango, and Zulu) there is no chance of

someone misunderstanding what letter you mean. If you say, "We need part number six alfa" instead of "six a," there is no chance that someone will confuse that with part 6k (which would be "six kilo"). The phonetic alphabet can also be used to spell out words that someone is having difficulty understanding.

The phonetic alphabet has been around for a long time, but has not always been the same. Back in the days of World War II, the phonetic alphabet began with the letters "Able, Baker, Charlie," *K* was "King," and *S* was "Sugar." After the war, when the NATO alliance was formed, the phonetic alphabet was changed to make it easier for the people who speak the different languages found in the alliance. That version has remained the same, and today the phonetic alphabet begins with "Alfa, Bravo, Charlie," *K* is now "Kilo," and *S* is "Sierra."

As you look over the phonetic alphabet, you will notice certain idiosyncrasies that you must accept. For example, the letter "Alfa" is spelled with an *f* instead of *ph*. This is because some of our allies do not have a *ph* in their language. Also note that "Whiskey" ends in "key," not "ky," and "Juliett" ends in two *t*s.

Pay close attention to the pronunciation of each letter. Note that in the table provided, each word is accented on the syllable in capital letters. This is no time for individuality—it is essential that everyone say these words as much the same as is possible to avoid any confusion, which is the whole purpose. The letter *p* should be pronounced "pah-PAH," not "POP-ah" as most Americans are more likely to say. *L* is "LEE-mah," not "LYE-mah," and *q* is "kay-BECK," not "quee-BECK."

a	alfa	AL-fah
b	bravo	BRAH-vo
c	charlie	CHAR-lee
d	delta	DELL-tah
e	echo	ECK-oh
f	foxtrot	FOKS-traht
g	golf	GOLF
h	hotel	hoh-TELL
i	india	IN-dee-ah
j	juliett	JEW-lee-ett
k	kilo	KEY-loh
l	lima	LEE-mah
m	mike	MIKE
n	november	no-VEM-ber

o	oscar	OSS-ker
p	papa	pah-PAH
q	quebec	kay-BECK
r	romeo	ROW-me-oh
s	sierra	see-AIR-rah
t	tango	TANG-go
u	uniform	YOU-nee-form
v	victor	VIK-ter
w	whiskey	WISS-key
x	xray	ECKS-ray
y	yankee	YANG-key
z	zulu	ZOO-loo

It is absolutely mandatory that you memorize the phonetic alphabet. You will be lost in the Navy without it.

Message Form. Most messages have three parts: the name of the station called, the name of the station calling, and the information to be sent. This format must always be followed. Call the station the message is for, identify your station, then transmit the message. It may seem strange to keep repeating these things, but keep in mind that there will probably be a number of people plugged into the circuit at the same time and they cannot see each other, so it is important to identify who you are and who you are talking to. Remember the order: who to, who from, what about. If you are on the anchor detail stationed on the forecastle and want to call the bridge, you would say:

"Bridge [who to], Forecastle [who from]; anchor secured [what about]."

When receiving a message, first identify your station, then acknowledge for the message with the words "aye, aye" or, simply, "aye." This means that you heard the message and understood it. It does *not* mean "yes." For example, if your station is the forecastle and the bridge has just ordered the anchor to be let go: "Forecastle, Bridge; let go the anchor."

Acknowledge that you understood what was said by answering with: "Forecastle, aye, aye" (or, "Forecastle, aye").

This does not mean that you (or anyone else) will let the anchor go. It means simply that you understood what was being said. When you pass this word on to the chief in charge of the anchor detail, she or he may tell you to tell the bridge that the anchor cannot yet be let go because the stopper is jammed. By saying "Aye, aye" you merely were saying "I heard and understood what you said."

You should note that in the above answer the forecastle did not say "Bridge, Forecastle, aye," but merely said "Forecastle, aye." This is because it is obvious who is being answered and to say "Bridge" would be unnecessary and unwanted talk to the circuit. It is acceptable (in fact, preferable) to abbreviate your conversation in this manner as long as it does not add to the confusion.

If you did not understand what was said, you should not answer "Aye, aye," but should say, "Bridge, Forecastle; repeat."

The following is a typical conversation you might have on the 1JV sound-powered circuit if you are on the forecastle as part of the anchor detail. For clarity, *your* words will appear in *italics*.

"Forecastle, Bridge; is the starboard anchor ready to let go?"

"Bridge, Forecastle; we are having trouble with the stopper."

"Forecastle, Bridge; report when the anchor is ready."

"Forecastle, aye."

[A minute goes by while the boatswain's mates are trying to free the stopper.]

"Bridge, Forecastle; the First Lieutenant says the bale is bent."

"Forecastle, Bridge; repeat."

"Bridge, Forecastle; the First Lieutenant says the bale is bent."

"Forecastle, Bridge; the 'what' is bent?"

"Bridge, Forecastle; 'bale.' Bravo, alfa, lima, echo."

"Bridge aye."

"Forecastle, Bridge; the Captain says he will back the ship down to keep us in our intended anchorage while you work on the stopper."

"Forecastle, aye."

"Bridge, Fantail; we have a small fishing boat astern of us."

"Bridge, aye."

In the last exchange, you can see that the talker at the fantail station, who is also on the circuit, warns the bridge that there is a fishing boat astern. This illustrates the importance of stations identifying themselves on the circuit when they speak. All of the prefacing with "Bridge, Forecastle" and "Forecastle, Bridge" in the above conversation seems unnecessary and awkward until you realize that there are other stations on the circuit, and it is important to know who is talking to whom in order to avoid confusion.

Circuit Testing. To find out if all of the stations on the circuit are manned and ready, the control-station talker would run a check of the circuit. For example, if the damage-control circuit is manning up and the control station (DCC) wanted to verify that all stations were on the line, the DCC talker would initiate the check by saying, "All Stations, Central; testing."

Each talker on the circuit then would acknowledge in the assigned order.

"Repair One; aye, aye."
"Repair Two; aye, aye."
"Repair Three; aye."
"Repair Four; aye, aye."

Normally each station answers in order, but does not wait more than a few seconds if the station ahead of it fails to acknowledge. If Repair Two fails to answer, Repair Three should, after giving Repair Two a few seconds to answer, go ahead and acknowledge for his or her station. If you were the talker in Repair Two and just came on the line while the check was going on, you should report in at the end, after all the other stations have made their reports in sequence. Do not try to jump in out of sequence—it may cause unnecessary confusion.

Integrated Voice Communications System (IVCS)

IVCS (spoken as "I-Vicks") combines the features of sound-powered phones, dial telephones, and intercom units into one sophisticated system with many advanced operating features. IVCS is capable of interfacing with other shipboard communications systems and consists of terminals (user access devices), computer-controlled interior communications switching centers (ICSCs), and a number of special accessories. In the event of a loss of electrical power, a battery back-up system keeps IVCS operating. Using "NETS" vice circuits, some of the more common ones are:

NET 15—Command Net; used for Combat Information Center (CIC) coordination.
NET 25—Combat Systems Equipment Control
NET 27—Electronic Control
NET 29—Underwater Systems Control
NET 66—AEGIS/Air Weapons Control
NET 74—Surface Weapons Systems Control
NET 80—Damage Control
NET 85—Electrical Service/Engineering Systems Control

Voice Tubes

A voice tube is exactly what it sounds like—a metal tube that allows stations to communicate with one another simply by talking into it. Large cones are fitted onto the ends of the tube to amplify the sound of your voice. Voice tubes require no electrical power, but their effectiveness decreases in direct proportion to the length of the tube, so they are used for short-distance communication only. A typical voice-tube installation would connect the bridge wings to the helm, enabling the conning officer to pass orders to the helmsman without having to come into the pilot house from the bridge wing.

External Communications

External communication involves two or more ships, stations, or commands. A ship communicates externally by a wide variety of methods, including messenger delivery, mail, flaghoist, semaphore, flashing light, radio, facsimile (FAX), teletype, whistle signals, and foghorns. The most significant forms of communicating are visual and electronic.

Visual Signaling

Despite this age of high technology when satellites and radios transmit communications at incredible speed, the oldest form of communication continues to play a vital role in the Navy. Visual communication has a distinct advantage over other forms. For all its advances, science has yet to produce a silent form of communication, one that cannot be detected by advanced technological equipment. Visual communication fills the need for a reliable, silent, and relatively secure means of communication at ranges up to 15 miles.

The three main types of visual signals are flashing light, semaphore, and flaghoist.

Flashing Light

Letters and numbers are broken down into short and long flashes of light known as Morse code. A transmitting signalman sends messages one letter at a time with a slight pause between each letter. The receiving signalman flashes a light for each word received until the message is complete.

Flashing-light signaling is accomplished by two methods, directional and nondirectional. With the directional method, the sender aims his light directly at the receiving ship or installation. The ship's

standard signal-searchlight is most often used but the *blinker tube* (or blinker gun) and the *multipurpose lamp* may also be used. The signal-searchlight is mounted to the ship's rail or to a special stand and is worked with levers attached to a blinking screen which allow the light to be quickly shown and blocked (to form the short and long flashes required for Morse code). The other two are portable, battery-operated lights with trigger switches to control flashes.

The nondirectional method is also called all-around signaling. Most of it is done by yardarm blinkers, lights mounted near the ends of the port and starboard yardarms on the mainmast and controlled by a signal key, similar to an old-fashioned telegraph, located on the signal bridge. This method is best for sending messages to several ships at once.

Lights used at night can be seen by an enemy, so an alternate system called "Nancy" uses invisible infrared light. Messages sent by this system can be seen only by those who have a special Nancy receiver, which gathers infrared rays and converts them to visible light. Nancy, with a range of from 10,000 to 15,000 yards, can be used only at night and is a more secure method of communication.

Semaphore

Semaphore requires little in the way of equipment and is relatively simple once the user becomes accustomed to it. Words are transmitted by holding the arms in a specific position to represent individual letters. When sender and receiver are close, as when their ships are alongside one another for UNREP, no special equipment is necessary. The semaphore characters are made simply by moving the hands to the proper positions. At greater distances, flags attached to short staffs held by the sender will make the signals much more visible. Standard semaphore flags are usually 15 to 18 square inches, and each staff is just long enough to grasp firmly. Most semaphore flags issued to the fleet today are fluorescent and made of sharkskin. For night semaphore, flashlights with special light-diffusing cones attached are held in the same manner as semaphore flags.

A good signalman can send or receive about 25 five-letter groups a minute. Only 30 positions need to be learned to be able to communicate by this method.

Semaphore is much faster than flashing light for short-distance transmissions. It may be used to send messages to several ships at once if they are in suitable positions but works best when used one on one. Because of its speed, semaphore is better adapted than the other visual methods for long messages.

PHC William H. Powers

Figure 22.5. Semaphore is a means of communicating that has stood the test of time.

Although semaphore's usefulness is limited somewhat by its short range, it is more secure than flashing light or radio because there is less chance of interception by an enemy or unauthorized persons. Speed and security, therefore, are the two factors favoring the use of semaphore.

Flaghoist

This is the most rapid system of visual signaling, but it can be used only in daytime. It is mostly used for transmitting tactical orders but

has some administrative uses as well. The meanings of each signal must be looked up in a signal book. There is a signal flag for each letter of the alphabet, a set of flags for each numeral 0 through 9, a set of pennants for each numeral 0 through 9, and other flags and pennants with special meanings. A compete set of signal flags will have sixty-eight flags and pennants. (See the appendices for a chart of all flags and pennants.)

Most ships carry only two or three complete sets of flags, but special substitute pennants may be employed to repeat flags that are already flying. The first substitute repeats the first flag or pennant in the same hoist, the second substitute repeats the second flag or pennant, and so on. With this system, there is virtually no limit to the combinations of flags and pennants that may be displayed (except for halyard space) and thousands of different signals can be sent.

Some signal flags have special meanings when used alone.

Bravo	Ship is handling explosives or fuel oil.
Five	Ship is broken down; cannot maneuver on its own.
Oscar	Man overboard.
Papa	Personnel recall. All hands return to ship.
Quebec	Boat recall. All boats return to ship.

Electronic Communications

Electronic communications used in the Navy take many forms. In the earliest days of radio, signals were sent by something called continuous wave which relied on Morse code as the means for transmitting signals. Later, voice radio came into being and revolutionized naval tactical communications. Other advances followed, including teletype, satellite communications, and facsimile (FAX).

Voice Radio

While you will certainly reap the benefits of modern electronic communications in the Navy, you will not be involved in using most forms unless you strike for radioman. One form, however, you will probably use on a frequent basis while standing watches or taking part in various operations. Voice radio or radiotelephone communications (RT) is often used as a fast, convenient, and efficient means of communicating. Ship to ship, ship to aircraft, aircraft to aircraft, ship to boat, and so on, voice radio is essential for many operations. Because of this, every Sailor should be able to communicate effectively using radio telephones, and because radios operate somewhat differently from the telephones you are used to, you

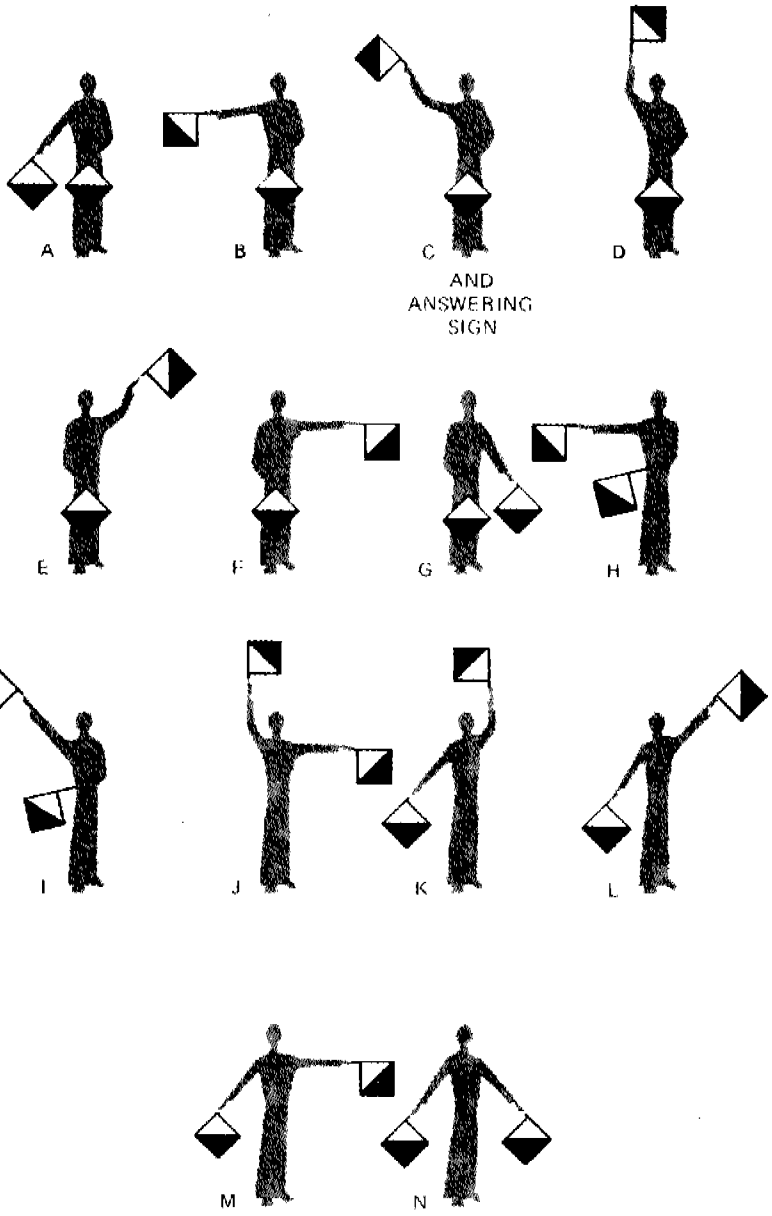
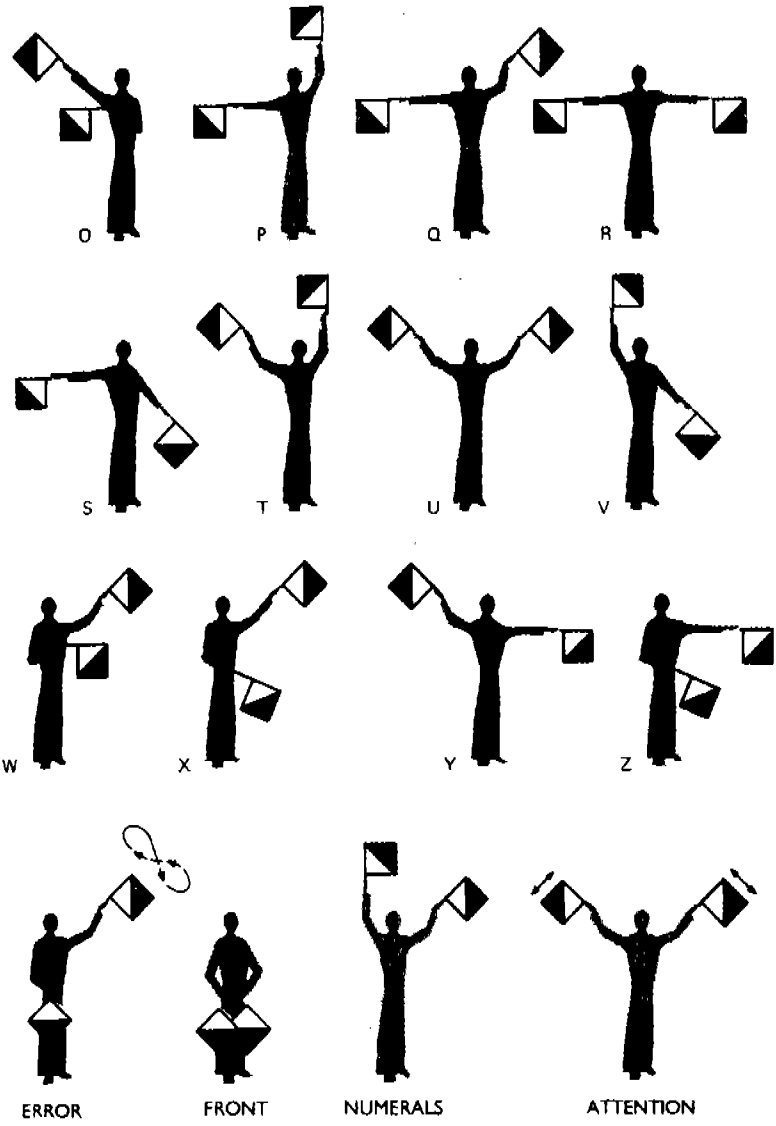


Figure 22.6. The semaphore signaling system is fast and reliable but useful only at short ranges.


O
P
Q
R
S
T
U
V
W
X
Y
Z
ERROR
FRONT
NUMERALS
ATTENTION

will need to learn a few new things in order to be an effective radio communicator.

For example, if you have watched movies and television as most people have, you must begin by *un*learning a particularly bad habit that has, for some reason, made its way into 90 percent of all such productions. The oft-used expression "over and out" makes no sense whatsoever, yet you will hear it used time and again on the big and little screens. In radiotelephony, "over" is a shorthand way of saying "I am finished talking and now it is your turn." "Out" means "I am finished talking and we have nothing more to talk about, so I am signing off." In short, "out" is roughly equivalent to "goodbye" on a telephone. So when actors say "over and out," they are, in essence, saying, "I am finished talking and now it is your turn. Goodbye." Needless to say, this makes no sense. Never, never, *never,* say "over and out" on a Navy radio circuit unless you enjoy being the butt of jokes.

Other words and phrases, called "prowords," have special meanings when used in voice radio communications. You should familiarize yourself with the partial list in Table 22.1.

Voice radio transmissions take the following form: the station called followed by the words "this is" and the identification of the station doing the calling. For example, if the call sign of your station is "Tango Charlie" and you are trying to call station "Delta Whiskey," you would say, "Delta Whiskey, this is Tango Charlie." The following example illustrates a radio conversation between these two stations.

"Delta Whiskey, this is Tango Charlie, over."

"Tango Charlie, this is Delta Whiskey, roger over."

"Delta Whiskey, this is Tango Charlie. When will your last boat be departing? Over."

"Tango Charlie, this is Delta Whiskey. The last boat will depart one hour before sunset. Over."

"Delta Whiskey, this is Tango Charlie. The Chief of Staff wants you to wait until General Scarloni arrives. Over."

"Tango Charlie, this is Delta Whiskey. Spell last name of general. Over."

"Delta Whiskey, this is Tango Charlie. I spell SIERRA, CHARLIE, ALFA, ROMEO, LIMA, OSCAR, NOVEMBER, INDIA. Over."

"Tango Charlie, this is Delta Whiskey. Say again all after LIMA. Over."

Table 22.1. Prowords and Their Meanings

Proword	*Explanation*
Authenticate	The station called is to reply to challenge that follows.
Authentication is . . .	The transmission authentication of this message is _____.
Break	I hereby indicate the separation of the text from other portions of the message.
Call sign	The group that follows is a call sign (identification of a station—similar to a "handle" in CB radio).
Correction	An error has been made in this transmission. Transmission will continue with the last word correctly transmitted.
Figures	Numerals or numbers follow.
I say again	I am repeating my transmission (or the portion indicated).
I spell	I will spell the next word phonetically.
Out	This is the end of my transmission to you and no answer is required or expected.
Over	This is the end of my transmission to you and a response is necessary. Go ahead; transmit.
Relay (to)	Transmit this message to all addressees immediately following.
Roger	I have received your last transmission satisfactorily.
Say again	Repeat your last transmission.
Silence	[Repeated three or more times.] Cease transmissions on this net immediately. Silence will be maintained until lifted.
Silence lifted	The silence that was imposed on this net is now lifted.
Speak slower	Your transmission is too fast. Reduce speed.
This is	This transmission is from the station whose designator immediately follows.
Unknown station	The identity of the station with which I am attempting to establish communications is unknown.
Wait	I must pause for a few seconds.
Wait, out	I must pause for longer than a few seconds.
Wilco	I have received your signal, understand it, and will comply. [Since the meaning of "Roger" is included in that of "Wilco," the two prowords are never used together.]

"Delta Whiskey, this is Tango Charlie. I say again all after LIMA: OSCAR, NOVEMBER, INDIA. Over."

"Tango Charlie, this is Delta Whiskey. Wilco. Out."

Transmitting Techniques

Because RT is used so widely in ships, aircraft, and motor vehicles, everyone should understand the basics of circuit discipline. Under most circumstances, the following practices are specifically forbidden:

Violation of radio silence
Unofficial conversation between operators
Transmitting in a directed net without permission
Excessive tuning and testing
Unauthorized use of plain language (no encryption)
Use of profane, indecent, or obscene language

Listen before transmitting—break-ins cause confusion. Speak clearly and distinctly; slurred syllables and clipped speech are difficult to understand. Speak slowly, so that the recorder has a chance to understand the entire message the first time. This way, you'll save time and avoid repetitions. Use standard pronunciation, not regional accents.

Keep the correct distance (about two inches) between your lips and the microphone. Speak in a moderately strong voice to override background noise. While transmitting, keep your head and body between sources of noise and the microphone.

Keep the volume of the headset earphone or speaker low. Pause momentarily, when possible, during your transmission by releasing the transmit button; pausing allows any other station with higher-precedence traffic to break in. Transact your business and get off the air. Preliminary calls are unnecessary when communications are good and the message is short. Do not hold the transmit button in the push-to-talk position until you're ready to transmit. Apply firm pressure to the transmit button to prevent an unintentional release.

Secure Voice Communications

If a transmission is in plain language, anyone can intercept and read it. Important messages may be encrypted and sent in a code or cipher known only to the sender and receiver. *Codes* are word-for-word substitutions, and both sender and receiver must use the same code book. *Ciphers* are letter-for-letter substitutions, which may require a machine for encoding and decoding. A coded message may be copied

by anyone, but without the code book it is difficult or impossible to read.

Modern communications equipment may include automatic encryption devices that "scramble" voice radio transmissions so that they are unreadable by unwanted parties and "unscrambled" by the intended receiver who has matching encryption/decryption devices.

23 Health, Fitness, and First Aid

In the days of "iron men and wooden ships," disease killed more men than did cannonballs. Sailors lived for months aboard damp and cold ships, ate salted or rancid meat and moldy or wormy bread, drank foul-smelling water, and bathed—if at all—in cold salt water.

Sailors in the Navy today live better and are safer and healthier than most people in the world. Even the smallest ship has facilities to provide nourishing meals, well-ventilated and heated berthing spaces, medical and dental attention, laundry services, hot and cold fresh water, and sanitary living conditions.

The Navy will train you to perform your military and professional duties, but your ability to perform them quickly and efficiently will depend to a large degree on your physical and mental condition.

U.S. Naval Institute

Figure 23.1. Regular medical attention is one of the benefits of Navy life.

Health and Fitness

Earlier in this book, you learned that in dealing with equipment you must practice preventive maintenance (such as cleaning and lubrication) to keep the equipment functioning at its peak performance and to minimize the chances of it breaking down. You also learned that effective and expeditious damage control can minimize the harm done to a ship and its equipment. The same principles apply to the human body. You can do a great deal of "preventive maintenance" to keep your body operating in top condition, and you can minimize damage in an emergency by knowing the basics of body damage control, known as first aid.

Personal Hygiene

Keeping yourself clean is one of the important basics of the "preventive maintenance" required to keep your mind and body in top shape. Harmful bacteria have great difficulty surviving in a clean environment, and the close living environment often found aboard ship requires that all hands must stay clean not only for their own health and well-being but for that of their shipmates as well.

Bathing

Your skin is actually a large organ that covers your body. It protects the more sensitive internal organs, helps regulate body temperature, assists with the body's fluid and chemical balance, and contains nerve endings that serve as sensors to pain, temperature, touch, and pressure. Keeping this important organ clean and healthy is vital to letting it perform its many jobs efficiently.

Bathing is the most effective way of keeping your skin healthy. Whether you accomplish it in a tub or shower, bathing removes disease-carrying organisms, stimulates the circulation of blood, soothes sore muscles, improves your self-image, and relaxes you.

Hand Washing

Hand washing is the single most important thing you can do to prevent infections and stay healthy. Done often and well, it breaks the chain of infection by removing organisms from your hands and preventing the spread of infection to yourself or others.

There are five important steps to avoid the spread of infection with your hands. Do them as often as you are able and you and others around you will be healthier:

Wash hands as often as practical.

Always wash hands after going to the head and before meals.
Use soap; clean between fingers and around nails.
Dry with a clean towel.
Avoid touching your face, especially your nose, eyes, and mouth.

Scabies

Scabies is a parasitic disease of the skin. Microscopic scabies "bugs" burrow into the skin and lay their eggs, leaving small red bumps or clear blisters. The mode of transmission is usually direct skin-to-skin contact, and often from sexual contact. Scabies may also be picked up by bedclothes and using undergarments owned by someone else.

Suspect scabies if you:

experience intense itching (especially at night and at belt line);
see small raised red bumps in a line with blisters; or
have a rash on your fingers, genitals, waistline, or in the elbow crease.

Report to sick bay if you suspect you have scabies. Medical personnel will give you medications to combat the problem and will instruct you to launder your clothing and bed sheets.

Lice

Lice are very small and may require a magnifying glass to be seen. However, it is usually easier to find the "nits," which are clusters of louse eggs. Nits appear as tiny white lumps on the shaft of hairs.

Over-the-counter (OTC) RID shampoo works very well. Be sure to launder any clothing and bed sheets used 48 hours prior to treatment. If treatment is unsuccessful contact your medical provider.

Care of Teeth

The three most common dental diseases are tooth decay (caries), inflammation of the gums (gingivitis), and an affliction of the gums and bone that surround the teeth (pyorrhea). Any of these problems can lead to the loss of teeth.

There is no way to completely prevent tooth decay, but it can be cut down by brushing your teeth correctly and by avoiding sweets. Flossing, the only way to remove harmful deposits from between your teeth, should be done at least once a day.

Normal healthy gums are pale pink and firm in texture. If they are swollen or puffy, hang loosely about the teeth, and bleed easily, then you have gingivitis. If gingivitis goes untreated, you may notice

pockets or crevices between the tooth and gum, an indication of pyorrhea. More teeth are lost from these two diseases than from tooth decay. It is required that all Navy personnel have their teeth checked at least once every year.

Tobacco, Alcohol, and Other Drug Abuse

One of the most effective ways to counter health and fitness is to introduce harmful substances into your body, particularly in large quantity. There are, unfortunately, parts of our society that encourage or even pressure us to practice such harmful behaviors. Before you consider using tobacco, alcohol, or any other drugs, and before you are tempted to write off some of the campaigns against these substances as overzealous or misdirected, simply consider the implications to your health. If you think these substances can be used with no consequences to your one and only body, you probably would also be willing to buy swampland as a real-estate development investment.

Tobacco

Once started, tobacco use is difficult to stop because the nicotine in tobacco is one of the most addictive substances known. Despite claims to the contrary by cigarette manufacturers, tobacco is as addictive as cocaine or heroin.

Tobacco use has many health hazards that the average smoker or dipper might not be aware of. Cigarette smoke contains 4000 chemicals, including the following highly toxic substances: carbon monoxide, a major component of automobile exhaust; formaldehyde, an ingredient of embalming fluid; and arsenic, a lethal poison. Smokeless tobacco is "doped" with higher concentrations of nicotine, sweeteners, and flavorings to make the product more addicting.

Tobacco use is the leading preventable cause of death in the United States; 500,000 Americans die of smoking-related illness each year, eight times as many as died in the Vietnam War. Everyone knows that smoking causes lung cancer. Some other cancers caused by tobacco include oral, bladder, kidney, prostate, uterine, ovarian, and cervical. People who use smokeless tobacco, or smoke cigars or pipes, think they are safe from the hazards of smoking, but the risks are potentially higher for mouth, tooth, and throat diseases and cancers.

Keep in mind that you are not only risking your own health by using tobacco, you risk the health of others around you as well. Pregnant women put their developing babies at serious risk of birth

defects and other complications by using tobacco. One nonsmoker dies of passive smoke for every eight smokers.

The Navy is aggressively working toward becoming a tobacco-free organization in the near future. If you use tobacco products and would like to quit, there are several methods to help you. Ask the medical staff how you can get help quitting. If you do not use tobacco products, don't start. Your body, your mind, and your wallet will all be better off.

Alcohol

The abuse of alcohol by Navy members can seriously damage physical and mental health, may jeopardize safety, and can lead to criminal prosecution and discharge under other than honorable conditions. Alcohol is a drug and should be treated with caution. Although millions of people use this drug regularly, it is a dangerous substance that requires a great deal of common sense and caution to be used rather than abused.

Alcohol abuse leads to intoxication; this is often when people get into trouble. Violence, sexual assault, loss of coordination that causes an accident, and arrests for drunkenness are just a few examples of alcohol abuse.

Alcohol abuse can progress into alcoholism, as well as serious health problems, including damage to vital organs (such as your brain and liver) and extremely harmful psychological problems.

Pregnant women face special risks when drinking by risking fetal alcohol syndrome, which can cause serious problems for a developing child, including physical defects, mental retardation, and even death.

The Navy recognizes alcoholism as a disease and, as such, is committed to providing treatment. Every Sailor suffering from an alcohol problem has the opportunity to be treated. See your command drug and alcohol program advisor (DAPA) if you think you need help.

Illegal Drugs

Other drugs, such as marijuana and crack cocaine, are not only extremely dangerous to your health, they are illegal as well. The Navy has a "zero tolerance" policy for drug abuse. Therefore, mandatory separation and other consequences (such as prosecution and loss of benefits) follow any illegal drug-related incident.

To enforce this policy, the Navy uses periodic urinalysis testing and other methods to discourage and identify drug abuse.

Male Health

Men have special health needs which are important considerations when dealing with the prevention and early detection of disease. Good health is no accident but is achieved through careful attention to personal hygiene and seeking medical care when appropriate.

Testicular Exam

Early detection and early treatment are among the best tools available in the fight against testicular cancer. If cancer is detected early, it is most curable. Every male is at risk for testicular cancer and should do a monthly testicular self-exam to detect any swelling or lumps.

Cancer of the testes is one of the most common cancers in men 15 to 34 years of age. If discovered in the early stages, it can be treated promptly and effectively.

Problems other than cancer involving the genitals can arise. Report to the nearest naval medical facility if you experience any unusual genital conditions, such as painful urination, penile discharge, or pain. "Testicular torsion," which is caused when one of the testes twists on its cord, will result in the surgical removal of a testicle if not treated within the first six hours of occurrence.

Contraception and Disease Control

The most effective means of contraception and disease control is, of course, to avoid sexual relations. The use of condoms during sexual intercourse is a reasonably effective method of both birth and disease control. While it is not 100 percent effective in either case, it is vastly more effective than having unprotected sex. A condom is a disposable, thin sheath of latex rubber that is rolled over the erect penis just before intercourse. The condom usually has a place at the tip to hold ejaculated semen, stopping the sperm from entering the vagina and preventing pregnancy. The effectiveness of the condom as a birth-control measure is increased by the use of a spermicide as well. To be effective, a new condom must be worn with every sex act.

If birth control is the only consideration, a surgical procedure called a vasectomy is an option, but it should be considered only when the desired effects are meant to be permanent.

Female Health

Like men, women have special health needs. Practicing good health habits can allow for early detection of diseases and allow a healthy and more active lifestyle.

Breast Self-Exam

A breast self-examination is a regular exam you do to check yourself for lumps, thickening, and dimples in the breast, or an unusual discharge from the nipple. Most cases of breast cancer are discovered by women themselves, through self-exams.

The best time to examine your breasts is once a month, one week after your period starts when your breasts usually are not tender or swollen. If you do not have regular menstrual periods, check your breasts on the first day of the month.

If you do not know how to do a self-examination effectively, visit your nearest naval medical facility for instructions and assistance.

Pap Smear

The Pap smear is a simple, relatively painless procedure that when properly performed by trained medical personnel is highly effective in detecting abnormal cervical cells before they become cancerous. Pap-smear screening should begin when a woman becomes sexually active or no later than the age of 18. It should continue annually, unless otherwise directed by a health-care provider.

Prevention of Pregnancy

Unplanned pregnancies can be a devastating consequence of indiscriminate sexual activity. Abstaining from intercourse is the safest behavior, but if a woman is sexually active, she should consider the following alternatives.

Condoms. Latex condoms are up to 85 percent effective at preventing pregnancy. The use of condoms is especially important because they are the *only* method of birth control which may also prevent transmission of sexually transmitted diseases. (See "Male Health" for description of condom use.)

Spermicides. Foams, gels, and suppositories are very effective as birth control when used alone. When used with a condom, effectiveness approaches 95 percent.

Prescription barrier methods. Barrier devices, such as the diaphragm or cervical cap, require initial fitting by a health-care provider. When used with a spermicidal gel, effectiveness at preventing pregnancy approaches 95 percent.

Prescription hormonal methods. Hormonal methods (pills, shots, and implants) are highly effective at preventing pregnancy, approaching 99 percent.

Natural family planning. The so-called rhythm method requires special instruction or training on the timing of intercourse.

Effectiveness is variable and this method is not recommended when pregnancy must be avoided.

Tubal ligation. Tubal ligation is an extremely effective form of birth control but should be considered an irreversible option that is only suitable for those who want permanent pregnancy prevention.

Perineal Hygiene

It is important to keep your genital area clean and dry to help prevent irritation and yeast and bacterial infection. Always wipe from front to back to prevent the spread of bacteria and feces from the rectum into the vaginal area. Wear clean cotton underwear or underwear with cotton panels daily and avoid nonabsorbent, heat-retaining clothing such as nylon pantyhose and tights. Change tampons or pads frequently and avoid deodorant varieties. Douching is not necessary for effective hygiene.

Premenstrual Syndrome

Known also as PMS, this term is used to define the physical and emotional symptoms that some women have during the week or two before menstruation, such as bloated stomach, weight gain, fluid retention, enlarged and tender breasts, and tension. Treatment depends upon the symptoms manifested and their severity. Some changes in lifestyle may help, such as eating less salty food or chocolate and not drinking alcoholic or caffeinated beverages. Exercise may help both physical and emotional symptoms.

Menstrual Cramps

Menstrual cramps are lower abdominal pain or discomfort during or just before a menstrual period. Menstrual cramps are sometimes associated with specific diseases or an underlying disorder, so it is important to seek professional medical help if you experience cramps that are severe, unscheduled, do not seem normal, or last more than two or three days.

Mild menstrual cramps are relieved by pain relievers such as *acetaminophen* or *ibuprofen.* If you choose or are prescribed ibuprofen, it is important to take it at the earliest onset of symptoms (bleeding or cramping). You may want to carry your medication with you to avoid a delay when your symptoms begin. A heating pad or hot-water bottle can also be used on your lower back or abdomen, or soak in a warm tub to help decrease discomfort. Exercising regularly, such as walking, swimming, or bicycling, may improve blood flow and

ease menstrual pain. Eat a diet rich in whole grains and green leafy vegetables. Drink plenty of fluids. Avoid smoking and excessive use of alcohol.

Nutrition

What we eat has a great deal to do with how we look and feel and plays a vital role in our ability to stay healthy. A good balanced diet will usually be available to you in most situations you will encounter in the Navy. Whether you reap the benefits of this opportunity is, of course, up to you.

Foods are grouped according to their benefits. A balanced diet uses an appropriate number of servings from each food group to provide enough calories and nutrients each day. Too much of any one food group is not good for you, nor is it healthy to completely avoid any one group completely.

If you have, or think you have, a weight problem, seek advice from professionals (trained medical personnel or certified nutritional experts) before embarking on a diet. Many diets do more harm than good.

Exercise

A regular exercise program has many benefits, including improving efficiency of the heart, increasing capacity of the lungs, decreasing body fat, and reducing the risk of coronary artery disease. Maintaining a regular fitness program can also allow you to pass the Physical Readiness Test (PRT) required on a periodic basis for all Navy personnel (see chapter 7).

When exercising, it is important to wear appropriate equipment. If you are running you should wear a good running shoe that is not old and worn out. If you run at least three times per week, you should get new shoes every six months. Playing court sports such as tennis or basketball require special court shoes. These shoes are designed to provide the proper support and prevent ankle injuries. If you are playing a sport where eye injury is a possibility (such as racquetball) it is important to wear the appropriate eye protection. Protective helmets, pads, and athletic supporters are vital when playing contact sports. If you exercise more than three or four times per week, it is important to mix activities like biking and running or stair-stepping and swimming. This is called cross-training and will be more effective overall as well as allowing your muscles, bones, and connective tissues to recover from the stresses of physical activity.

Treatment of Illness and Injury

Despite proper preventive health and fitness measures, illness and injuries will still occur for most people. This section is a basic guide to help you handle common illness and injury. It will give you information on the signs and symptoms, common causes, transmission, prevention, and treatment of these problems. It will also help you to decide when to seek medical attention. It is by no means meant to replace medical treatment. If you are in doubt it is always better to seek advice and treatment from trained medical personnel than to take unnecessary risks with your health.

Use this information as a tool to keep yourself healthy and safe, thereby maintaining your optimal physical and mental condition.

Foot Care

Few jobs or responsibilities in the Navy do not require you to use your feet in one way or another. Whether you must stand a quarterdeck watch or run to your battle station, your feet are a vital part of your ability to do your job. Some foot problems are relatively common and can be fixed with minor treatment. Others can be more serious and require medical assistance.

Blisters

Blisters are a buildup of fluid beneath the skin in response to friction. They are commonly caused by new or improperly fitting shoes, or a sudden increase in activity that results in harmful friction. If not treated properly, a "simple" blister can become infected and require hospitalization. Since the skin covering a blister provides protection from infection, it should be left intact when possible. If the lesion is in an area susceptible to continued irritation, then the fluid can be expressed by puncturing the base of the blister with a sterile needle. The blister should be padded with moleskin, gauze, or a bandage. Antiseptics such as betadine or antibiotic cream can also be applied.

Athlete's Foot

"Athlete's foot" is the common name given to a fungus skin infection of the feet that is characterized by dry white scaling skin on the sole of the foot. It can exhibit varying degrees of itching. Between the toes it can cause peeling and fissuring (cracking) of the skin. Sometimes it causes small blisters filled with clear liquid. It is usually located on the sole or instep of the foot. Contributing factors include occlusive excessive foot perspiration, humid weather, and walking barefoot in

community shower facilities. Preventive measures include daily foot washes, sock changes twice per day, shower shoes, and antifungal medications. Treatment consists of seeking medical attention and proper foot care and hygiene.

Ingrown Toenail

An ingrown nail occurs when the side of the nail penetrates the skin. This can be caused by trimming the nail too short, tightly fitting shoes, or trauma. Once the nail has penetrated the skin, pain and infection result. The toe becomes red, swollen, and has a pus drainage. If left untreated, this can result in serious infection of skin and bone. Removal of the offending nail border by a medical provider is the best treatment. To prevent this problem, you should trim your toenails straight across and do not round the edges.

Stasis Cellulitis

Prolonged standing can lead to an accumulation of blood and fluid in the feet and legs, causing them to become red and swollen. If not properly treated, infection can occur. Seek medical attention immediately.

Eye Injuries

Even with the best of precautions, eye injuries are sometimes unavoidable. To help decrease the chances of permanent damage to the eyes, proper steps can be taken following an injury. The following information is provided to give you a basic understanding of which conditions can be self-treated and which ones need immediate medical attention.

Black Eye

A black eye can occur from a blow to the ocular region and is actually a bruise. Standard treatment is as follows:

- A cold compress should be placed on the injured area right away.
- Over-the-counter medicine such as acetaminophen can be taken to decrease the pain.
- Warm compresses can be used afterwards to help the healing process.
- If there is double vision, decreased vision, severe eye pain, or the above procedures do not help, seek medical attention.

Foreign Bodies in the Eye

Small objects such as paint chips, metal flecks, or sawdust can sometimes get into the eye. Treatment is as follows:

Wash your hands. Use a cotton swab, corner of a handkerchief, or twisted piece of tissue moistened with clean water (not saliva) to touch and lift away the particle from the eye gently. Never remove a foreign body from the eye using your fingers, tweezers, or sharp objects.

If the foreign body is embedded and not easily removed you should seek medical attention. Refrain from rubbing your eyes. If a foreign body is actually stuck into the eye or the eyeball itself is cut, *no pressure* should be placed on the eye. Cover the affected eye with a paper cup taped into place or other clean object that does not touch the eye. Cover the opposite eye with a sterile cloth bandage to reduce movement of both eyes. Seek immediate medical attention as soon as possible.

Abrasions to the Eye

The cornea (clear covering over the pupil) is very sensitive to pain; an abrasion to the cornea will cause the patient to be sensitive to light, experience sharp pain, and have red eyes and possible vision decrease. Seeking immediate medical attention is appropriate.

Burns to the Eye

After a chemical burn to the eyes, it is extremely important to immediately rinse the eye out with clean water or sterile saline solution for a minimum of 30 minutes. The proper procedure is:

Hold the affected eye open with your thumb and forefinger.

Pour large amounts of warm (not hot) water from a clean container over the entire eye. Direct the water from the inside corner of the eye (by the nose) and let the water run down toward the outside corner of the eye to keep the chemical from spreading to the other eye.

If both eyes are affected, quickly alternate the above rinsing procedure to both eyes.

If you are by yourself or you cannot keep the victim's eye open, you can fill up a sink or container with warm water, stick the victim's face in the water, and have them blink repeatedly.

After rinsing the eye out, loosely bandage the eye or eyes with a sterile cloth and seek immediate medical attention.

As with all injuries, it is far better to *prevent* a chemical burn to the eye than to treat it. Certain safety precautions are paramount when working with chemicals that can damage your eyes:

Always wear safety glasses.
Do not rub your eyes after using chemicals.
Always wear gloves.
Turn your head away from chemical vapors to prevent eye injury.
Wash your hands when finished.

Conjunctivitis (Pink Eye)

Conjunctivitis can be extremely contagious. You should see an eye doctor when your eyes burn, become red, watery, itchy, and/or present with mucous-like discharge. Precautions you should take are as follows:

Towels and linens should not be shared and should be washed frequently to decrease the spread of infection.
Never share eye makeup.
Avoid contact lens use when pink eye is suspected.
Avoid touching your eyes to decrease the chances of spreading the infection to the unaffected eye or to another person.
Wash your hands frequently.

Orbital Fractures

The most common cause of orbital fracture (skull fracture around the eye) is blunt trauma to the face. Seek medical attention immediately if a fracture is suspected. Bruising and swelling of the eyelids, difficulty with eye movements, and double vision are all possible indications of orbital fracture.

Retinal Detachment

The sudden appearance of flashes of light off to the side of your vision, numerous floating particles, or the feeling that a dark curtain is obstructing part of your vision are all symptoms of this serious problem. Immediate medical attention is needed to prevent permanent vision loss.

Ten Ways to Keep Your Eyes Healthy

1. Get a complete eye exam every year.
2. Wear your correct contact lens or glasses prescription as indicated by your eye doctor.
3. Do not sleep with your contact lenses in place unless your eye doctor specifically fit you with a special pair designed to be

worn overnight. Even then, you must never sleep in your contact lenses for more than six nights in a row before taking them out to clean and disinfect them. Failure to do so may result in permanent eye damage.

4. Contact lenses should be removed immediately if your eyes become red, painful, or if you notice a decrease in your vision. Carefully inspect the contact lens and do not wear again if you notice any chips or tears. You should see an eye-care provider before wearing your lenses again or if these symptoms persist.
5. Always wear suitable eye protection (shields, goggles, or safety glasses) when working with harmful chemicals and dangerous machinery. Safety glasses should also be worn during jobs that expose your eyes to materials such as sawdust, paint chips, or metal flecks.
6. Keep your eyelids healthy by cleaning the outside skin of the lids on a daily basis. This will reduce the formation of sties (painful lumps in the eyelid) and also decrease eye infections.
7. Do not share makeup as infections are easily spread this way.
8. Do not stare directly at the sun, bright lights, fires, or welding arcs.
9. Wear ultraviolet eye protection when in the sun or in tanning beds.
10. Eye injuries should be taken seriously. When in doubt, seek medical attention.

Diarrhea

Diarrhea is the passing of unusually loose and frequent bowel movements. It may cause discomfort and is often accompanied or preceded by cramping pains in the lower abdomen. Diarrheal illness can be very dangerous when dehydration develops. In this country, most attacks of diarrhea are the result of viral infection and last no more than 48 hours. No special treatment is usually warranted other than ensuring that you drink enough fluids. However, if diarrhea persists or recurs, seek medical assistance.

Diarrhea caused by bacteria is more serious. A visit to a country where sanitation standards are low may expose you to bacteria found in inadequately purified water or in contaminated milk and food. This is known as *traveler's diarrhea.* Therefore, eat only well-cooked food and drink only water and milk that have been boiled or sterilized. Again, if you have diarrhea lasting greater than 48 hours, seek medical attention.

Dysentery is a serious digestive-tract infection that is more common in hot countries but one that also occurs in the United States. It causes violent blood-stained diarrhea with fever, vomiting, and abdominal pain. If you have these symptoms, seek medical help immediately.

Sexually Transmitted Diseases

Sexually transmitted diseases (STDs) are infections that are usually spread by sexual contact. They used to be referred to as venereal disease or just "VD"; you may still hear that term or the slang term "clap" used when people are referring to STDs. The most effective means of avoiding STDs is, of course, to avoid sexual contact, but other effective means of reducing the risk are having only one sexual partner and the use of condoms.

It is a strange characteristic of our society that STDs are often the subject of jokes or are viewed by some as a badge of conquest. But make no mistake, there is nothing funny or admirable in contracting one of these diseases. STDs can permanently damage your reproductive organs, causing infertility. They can also cause heart disease, blindness, deafness, arthritis, and death. If a woman is infected during pregnancy she could have a miscarriage or pass the infection to her unborn baby.

If you suspect you have a STD or have been told by your partner that he or she was treated for a STD, refrain from further sexual encounters and seek medical treatment as soon as possible.

If you have any of the following symptoms, you should seek medical attention:

genital sores or warts
painful urination
genital pain during sex
unusual genital discharge
rashes in the genital area
swollen lymph nodes
unexplained weight loss
sudden loss of hair

Some of the common STDs can be treated or cured, others cannot. AIDS (acquired immune deficiency syndrome) is caused by HIV (human immunodeficiency virus). This virus infects a person's blood and attacks the cells that normally protect people from infection and cancer. An infected person may have no symptoms initially, but over

the years the immune system weakens, causing the victim to lose the ability to fight off other diseases and disorders. The average time from HIV infection to the onset of AIDS is approximately 10 years. While advances have been made in medicine and treatment, there is no cure for HIV/AIDS.

First Aid

When an injury occurs, the first choice is obviously to have someone with the appropriate medical training take care of the problem. But it is also obvious that there will be many occasions when a person has been injured and there is no medically trained person around. Waiting for medical attention is not an option if the person is going to have any chance of survival in cases where breathing has stopped or there is severe bleeding. In these instances, what is popularly known as first aid can make the difference between life and death or between serious and minor injury.

CPR

Cardiopulmonary resuscitation (CPR) is used only for sudden cardiac or respiratory arrest. CPR is a temporary action performed by someone *trained* in performing CPR. This brief description of the emergency procedures for the adult cannot substitute for approved CPR training.

Important: Call for help as soon as the victim is discovered unresponsive. Then check ABCs (airway, breathing, circulation).

One-person Adult CPR

1. Gently position the person on his back and open the airway by pushing the head back and lifting the jaw.
2. Look, listen, and feel for breathing.
3. If the person is not breathing, seal your mouth around his and give two slow breaths, each lasting 1 to 1.5 seconds.
4. Feel for a pulse. If there is a pulse, breathe for the adult with one breath every 5 seconds. If no pulse, start chest compressions.
5. Chest compressions begin with the heel of one hand two-thirds of the way down the breastbone and your other hand on the top. Compress chest 1 to 2 inches. Continue compressing three times every 2 seconds (80 to 100 per minute). After 15 chest compression, give two breaths. Repeat until a pulse returns or medical help arrives.

Choking

The universal sign for choking is grasping the neck with both hands. If severe breathing difficulties occur and the victim is unable to cough up the object, such as a piece of food, use the following procedure (called the *Heimlich Maneuver*) to dislodge it:

Stand behind the victim and wrap your arms around the victim's waist (see figure below). Press one fist against the abdomen and below the rib cage. Then grasp your fist with the other and perform quick upward thrusts into the abdomen.

Unconscious victims should be rolled onto their back. Kneel astride the victim's thighs and use quick upward abdominal thrusts using the heel of your hand. Repeat 6–10 times, then check for the obstruction by sweeping the victim's mouth with your finger.

If you are the one who is choking, bend over the back of a chair thrusting your abdomen sharply. Repeat until object is dislodged.

Bleeding

It is important to note that the body only contains five quarts of blood. Prolonged bleeding from any type of wound can be life-threatening. Quick action in the rendering of first aid is required to minimize the loss of blood by controlling the bleeding.

Types of Bleeding

There are three types of bleeding:

Capillary bleeding is commonly characterized by a superficial wound with oozing blood easily controllable with direct pressure.

Venous bleeding is denoted by its dark color of red or maroon.

Arterial bleeding, which is easily recognizable by the bright red color and the typical pulsating bleeding at the wound site or, in the case of a deep wound, has a continuous bright red flow.

If you are confronted with multiple wounds on the same victim, you should treat them in the following order: arterial first, venous second, and capillary third.

Treatment of Bleeding

Treatment of the bleeding wound will depend upon the type and location of the wound. There are different methods that may be used to stop bleeding.

Direct pressure. Most external bleeding can be controlled by applying pressure directly over the wound. Use what is available (such as a clean cloth or a part of clothing). The cleaner the material

the better in preventing infection. Application of the bare hand may be necessary in stemming a major loss of blood until more effective cloth material can be brought to use. After the bleeding has been controlled, apply layers of cloth to form a good-sized covering, and then bandage firmly. Do not remove the dressing. If blood saturates the dressing simply apply more cloth or dressing material to the site. Removal of the dressing may pull away the blood clot and bleeding may resume.

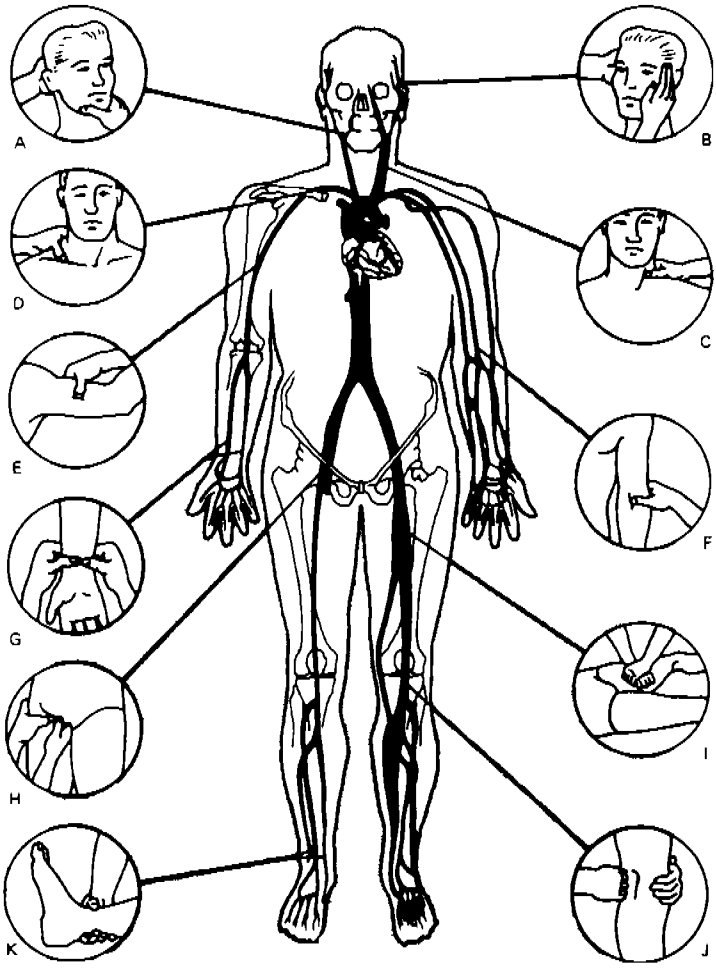


Figure 23.2. Pressure applied to the appropriate point on the body is an effective method of reducing or stopping blood flow.

Pressure points. For especially quick action, you can use your fingers or the heel of your hand to compress the supplying vessel against the underlying bone. Merely feel for the pulse directly above the wound (closer to the heart) and press against the bone in that particular area until the blood flow is diminished or stopped. Note that arteries run along the inner sides of the long bones in the body, and along the inner sides of the jaw. *Never* apply the pressure point method to injuries of the neck.

Tourniquet. This is the least desirable method of controlling bleeding because it is difficult to do correctly. It is and should always be the *last resort* when all other methods have failed. It is also important to note that any site at or below where the tourniquet is applied will have no nutrients or oxygen supply. The tissues will soon die, necessitating the ultimate loss of the limb.

When applying the tourniquet, place the dressing over the wound, wrap the bandage around the limb as close to the wound as possible and tear or cut the bandage into two tails at the exposed end. Tie an overhand knot around a stick, screw driver, pencil, or any material along those lines. Twist the bandage material until bleeding is stopped. Secure the stick or whatever the material you have used with a square knot to keep the bandage from unraveling and losing pressure over the wound. Once a tourniquet is applied it must never be removed except by a trained medical professional. If, for some reason (such as moving on to help other victims) you must leave the victim, mark her or his forehead with a *T*. Try to use something other than blood because it might be accidentally wiped away or might dry and flake off. On one side of the *T* write the location of the tourniquet (right leg, left arm, or whatever). On the other side of the *T* write the date and time it was applied.

Shock

Shock is a life-threatening condition that may occur with severe injury or illness. Shock may begin immediately, or it may be delayed for several hours. A shock victim has inadequate flow of blood to vital organs and tissues.

Signs and Symptoms of Shock

A person in shock may insist that they feel fine, and then pass out. The following indications will help you to identify when a victim is in shock:

Weak and rapid pulse
Breathing may be shallow, rapid, or irregular

Pale, cool, and moist skin
Dilated pupils
Drowsy, restless, or anxious

Treatment of Shock

Call for emergency medical help immediately. Do not give food or fluids. Lay the victim down on his or her back, raise both legs, loosen all tight clothing, and keep him or her warm.

Burns

Burns may be caused by dry heat (fire), moist heat (steam or hot liquids), electricity, or corrosive chemicals. To treat any burn, *first remove the cause.*

Superficial burns may not be serious but they are very painful, so first aid is performed mainly by cooling the area with cold running water for 10 minutes. If blisters form, do not break them. If the burn is on a part of the skin that can be rubbed by clothing, cover the area with a padded dressing. Do not apply any cream, grease, ointment, or butter. The exception is mild sunburn, which can often be soothed with over the counter anesthetic lotions or spray.

Serious burns cause extreme pain. Treat for shock immediately before trying to treat the burns. Keep the victim's head slightly lower than the feet and keep them warm. Cover all burns with dry, sterile dressings. A seriously burned person badly needs fluids. If the victim is conscious, able to swallow, and has no internal injuries, give her or him water, fruit juice, or sugar water.

Chemical burns can cause extensive destruction of body tissue. This kind of injury can be caused by acids such as nitric, sulfuric, and hydrochloric acid or by caustic alkalis such as potassium hydroxide (lye), sodium hydroxide, and calcium hydroxide. The best treatment of chemical burns is to wash the chemical off immediately with large amounts of clean, fresh, cool water. If possible, immerse the affected areas. Do not break any blisters. Cover the burns with dry sterile dressings and transport to nearest medical facility.

Fractures

There are two principle types of fractures, *simple* and *compound.* A simple fracture is a broken bone that does not break the skin. A compound fracture is characterized by the jagged edge of bone causing a break in the skin. The latter is more serious because of the high potential for infection and the potential loss of blood.