Safety officer. On ships that do not have safety departments, the safety officer will advise the CO and XO on matters pertaining to safety aboard ship. She or he will be accorded department-head status for safety matters and will coordinate the ship's safety program.

Command Master Chief. The command master chief (CMDMC) assists the CO in matters of morale and crew welfare. [See chapter 9 for more detail.]

Senior watch officer. The senior watch officer is responsible for assigning and supervising all deck watchstanders, underway and in port. He or she coordinates the ship's watch bill, ensuring that trained personnel are equitably assigned to all necessary stations under all conditions. The senior watch officer is usually the most senior person among those who are standing watches.

Ship's secretary. Administering and accounting for correspondence and directives, and maintaining officers' personnel records, are among the responsibilities of the ship's secretary. He or she also supervises the preparation of the captain's official correspondence.

Training officer. The training officer coordinates the ship-wide training program. He or she will obtain and administer school quotas, provide indoctrination training to newly arrived personnel, coordinate with the operations officer in scheduling training exercises, and supervise the ship's personnel qualifications system (PQS).

Security manager. The security manager is responsible for information-systems and personnel security, the protection of classified material, and security education.

3-M coordinator. The various aspects of the ship's maintenance and material management (3-M) program are supervised by the 3-M coordinator.

Departments and Divisions

Different ships have different departments, depending upon their size and mission. Some examples of commonly seen departments are *engineering, operations,* and *supply.* Ships whose primary mission is combat may have a *weapons* department, or it may be called *combat systems* on more sophisticated ships. Ships whose primary mission is logistical—involving replenishment of fuel, ammunition, or other supplies at sea—will often have a *deck* department.

Departments are subdivided into divisions, and divisions are often further subdivided into work centers, watches, and/or sections with petty officers in charge of each.

Each ship's department has a department head, an officer who is responsible for its organization, training, and performance. The

larger the ship, the more senior the department head will be. In a destroyer the department head is often a senior lieutenant, while in aircraft carriers department heads are usually commanders.

Divisions have a division officer responsible for them. The division is the basic working unit of the Navy. It may consist of twenty specialists on small ships or as many as several hundred persons in a division on an aircraft carrier. The division officer is the boss; he or she reports to the department head and is frequently a junior officer but can be a chief petty officer or a more senior petty officer if the situation calls for it. The division officer is the one officer with whom division personnel come into contact every day. The division chief and the leading petty officer are the division officer's principal assistants. Larger divisions may have more than one chief assigned and may even have other junior officers assigned as assistants. These larger divisions may also have one or more technical and material assistants—usually warrant officers or limited-duty officers—to supervise the maintenance and repair of material or equipment.

In the first chapter of this book, you read about the chain of command, learning that it changes from assignment to assignment. When you report to your first ship, you will have a new chain of command that might begin with your section leader or work center supervisor, who reports to the division chief, who in turn reports to your division officer, who answers to the department head, whose boss is the executive officer, who reports directly to the captain, and so on.

Departments aboard ship belong to one of three different categories: command, support, or special.

Command Departments

Depending upon the type of ship, the command departments found on board are air, aircraft intermediate maintenance, aviation, combat systems, communications, deck, engineering, executive, navigation, operations, reactor, safety, and/or weapons.

Air. The Air Department is headed by the air officer (informally referred to as the "air boss"), who supervises and directs launchings, landings, and the handling of aircraft and aviation fuels.

On a ship with only a limited number of aircraft, the department consists of a V division with the V division officer in charge. On ships with large air departments, additional divisions are assigned: V-1 (plane handling on the flight deck), V-2 (catapults and arresting gear), V-3 (plane handling on the hangar deck), V-4 (aviation fuels), and V-5 (administration). The division officers responsible for these four divisions are known as the flight deck officer for V-1, the cata-

pult and arresting gear officer for V-2, the hangar deck officer for V-3, and the aviation fuels officer for V-4.

Aircraft intermediate maintenance. The head of this department (usually referred to simply as "AIMD") is the aircraft intermediate maintenance officer, who supervises and directs intermediate maintenance for the aircraft on board the ship. The AIMD also keeps up ground-support equipment. When there is only one division aboard ship, it is called the IM division. Ships having more than one division include the IM-1 division (responsible for administration, quality assurance, production and maintenance/material control, and aviation 3-M analysis), the IM-2 division (for general aircraft and organizational maintenance of the ship's assigned aircraft), the IM-3 division (for maintenance of armament systems, precision measuring equipment, and aviation electronic equipment, known as "avionics"), and the IM-4 division (for maintenance of other aviation support equipment).

Combat systems. Because of their complexity and sophistication, submarines and certain classes of cruisers, destroyers, and frigates have a combat systems department instead of a weapons department. Some of the functions covered by the operations department on those ships with a weapons department are included in combat systems on these vessels. Some of the divisions found in these departments are CA (antisubmarine warfare), CB (ballistic missile), CD (tactical data systems), CE (electronics repair), CF (fire control), CG (gunnery and ordnance), CI (combat information), and CM (missile systems).

Communications. In ships large enough to have a communications department, the head of the department is the communications officer, who is responsible for visual and electronic exterior communications. Her or his assistants may include a radio officer, a signal officer, a communications security material system (CMS) custodian, and a cryptosecurity officer. The department may be divided into CR (for radio) and CS (for signals) divisions. In smaller ships, the communications officer is a division officer reporting to the operations officer. In this case, the division is usually called OC division.

Deck. Some ships, such as aircraft carriers, have both a deck department and a weapons department; other ships have only one or the other, depending upon their mission. On ships with a deck department, the first lieutenant is the head of that department which consists of divisions called 1st Division, 2nd Division, and so on. On ships that do not have a deck department, there is a division in the weapons department, usually called 1st Division, and the first lieutenant in this case is a division officer rather than a department head. Aboard those ships having only a deck department (such as an AO) and not a

weapons department, ordnance equipment, small arms, and other weapons are the responsibility of a division headed by a gunnery officer. Personnel assigned to the deck department (or division) carry out all seamanship operations, such as mooring, anchoring, and transferring cargo from ship to ship while underway.

Engineering. This department, headed by the engineering officer (also called the chief engineer), is responsible for the operation and maintenance of the ship's machinery, the provision of electrical power and fresh water, damage control, hull and machinery repairs, and the maintenance of underwater fittings. Ships large enough to have more than one division in the engineering department might have a B division for boilers, M for main engines, MP for main propulsion, A for auxiliaries, E for electrical, IC for interior communications, and/or R division for repair.

Executive. Some ships have an executive department made up of one or more divisions. (Aircraft carriers have an administrative department, which is similar in nature and function to the executive department in other ships.) This department is headed by the XO and may have an X division, which includes personnel assigned to work in the CO's office, XO's office, chaplain's office, print shop, security office, training office, legal office, and sick bay (when no medical officer is assigned). It may also include an I division used for the indoctrination of newly reporting personnel.

Navigation. This department, headed by the navigator, is responsible for the ship's safe navigation and piloting and for the care and maintenance of navigational equipment.

Operations. This department, often called "Ops," is headed by the operations officer, who is responsible for collecting, evaluating, and disseminating tactical and operational information. For ships with more than one division, the department could include OA, OC, OD, OE, OI, OP, OS, and OZ divisions. OA includes intelligence, photography, drafting, printing and reproduction, and meteorology. OC handles communications, but on ships having a large air contingent, such as CVs, LPHs, and LHAs, OC is the carrier air-traffic-control-center division. OD division covers the data-processing functions. OE is the operations electronics/material division. OI includes the combat information center (CIC) and sometimes the lookouts. OP is the photographic intelligence division. OS division handles communications intelligence. OZ is the intelligence and/or cryptologic operations division.

The following officers, when assigned, will usually report to the Ops officer: air intelligence, CATCC officer, CIC officer, communi-

cations (COMM) officer, electronics material officer (EMO), electronic warfare (EW) officer, intelligence officer, meteorological officer, photographic officer, strike operations officer, and computer programmer (or computer-maintenance officer).

Reactor. CVNs have this department in addition to the engineering department. The reactor officer, who heads this department, is responsible for the operation and maintenance of reactor plants and their associated auxiliaries. Divisions found in the reactor department include RA (auxiliaries), RC (reactor control), RE (electrical), RL (chemistry), RM (machinery), and RP (propulsion). Because of the special responsibilities of running a reactor plant and its obvious close ties with the engineering functions of the ship, the reactor and engineering officers must closely coordinate their activities.

Weapons. The weapons officer supervises and directs the use and maintenance of ordnance and (in ships without a deck department) seamanship equipment. On ships with antisubmarine warfare (ASW) arms and a weapons department, the ASW officer is an assistant to the weapons officer. Other assistants, depending upon the ship and its weapons capabilities, are the missile officer, gunnery officer, fire-control officer, and nuclear weapons officer. On some ships, the CO of the marine detachment may also answer to the weapons officer.

Some of the divisions that may be included in the weapons department are F division (fire control), F-1 (missile fire control), F-2 (ASW), F-3 (gun fire-control), G (ordnance handling); GM (guided missiles), V (aviation, for ships without an air department but with an aviation detachment embarked), and W (nuclear-weapons assembly and maintenance).

Support Departments

Because of its obvious importance, most Navy ships will have a supply department. Smaller ships will have one or more hospital corpsmen assigned to handle the medical and health needs of the crew, but larger ships will have a medical department and a dental department with one or more doctors, dentists, nurses, and/or medical service corps officers assigned. Ships with one or more judge advocate general (lawyer) officers on board will have a legal department.

Supply. Headed by the supply officer, this department handles the procurement, stowage, and issue of all the command's stores and equipment. The supply officer pays the bills and the crew and is responsible for supervising and operating the general and wardroom messes, the laundry, and the ship's store. Ships large enough to have multiple divisions may have an S-1 division (general supply support),

S-2 division (general mess), S-3 division (ship's stores and services), S-4 division (disbursing), S-5 division (officers' messes), S-6 division (aviation stores), and S-7 division (data processing).

Medical. The medical officer is responsible for maintaining the health of personnel, making medical inspections, and advising the CO on hygiene and sanitation conditions. Assistant medical officers may be assigned. H division is normally the only medical division.

Dental. The dental officer is responsible for preventing and controlling dental disease and supervising dental hygiene. Assistant dental officers are sometimes assigned to larger ships. D division is normally the only dental division.

Legal. The legal officer is responsible for handling all legal matters, particularly those pertaining to the UCMJ.

Special Departments

Certain ships have unusual missions and therefore require special departments. Included among these are aviation, boat group, deep submergence, marine detachment, repair, safety, transportation, and weapons repair.

Aviation. On a nonaviation ship with a helicopter detachment embarked, an aviation department is organized and headed by the aviation officer. The aviation officer is responsible for the specific missions of the embarked aircraft. His principal assistant may be a helicopter control officer, but often one officer performs both functions.

Boat group. Assault transports (LPDs and LSDs) have a boat-group department whose responsibilities include the operation and maintenance of the embarked boats.

Deep submergence. This specialized department, which is found on only a few naval vessels, launches, recovers, and services deep-submergence vehicles (DSVs) or deep-submergence rescue vehicles (DSRVs).

Marine detachment. The marine detachment assigned to some ships serves as the ship's landing party, provides ship security, operates the ship's brig, and provides orderlies for certain senior officers. The head of the marine detachment is not technically a department head, nor does he or she function as a division officer. She or he is the commanding officer of the detachment, in charge of matters pertaining strictly to the Marine Corps, but often is subordinate to the weapons officer in shipboard matters.

Repair. On ships with a large repair function, there will be a full department with a department head called the repair officer. On

multiple-division ships, there may be an R-1 division (hull repair), R-2 division (machinery repair), R-3 division (electrical repair), R-4 division (electronic repair), and R-5 division (ordnance repair).

Safety. Larger ships, particularly those who conduct potentially hazardous operations on a routine basis, will have a safety department assigned.

Transportation. Only Military Sealift Command (MSC) transports have this department, headed by the transportation officer. The department is responsible for loading and unloading, berthing and messing, and general direction of passengers. On ships without a combat cargo officer, the transportation officer is also the liaison with loading activities ashore. Larger ships may have a T-1 division, which has the physical transportation responsibilities, and a T-2 division, which handles the administrative end of transportation.

Weapons repair. This department, found only on tenders, usually has a single division, designated SR. A large department may be subdivided into the SR-1 division (repair and service) and the SR-2 division (maintenance of repair machinery).

Aircraft Squadrons

Operating squadrons, like ships, have a CO, an XO, department heads, and division officers.

Commanding Officer

The CO, also known as the squadron commander, has the usual duties and responsibilities of any captain insofar as they are applicable to an aircraft squadron. These include looking after morale, discipline, readiness, and efficiency, and issuing operational orders to the entire squadron.

Executive Officer

The XO, the second senior naval aviator in the squadron, is the direct representative of the CO. The XO sees that the squadron is administered properly and that the CO's orders are carried out. The executive officer, as second in command, will take over command of the squadron whenever the CO is not present.

Squadron Departments

Operational squadrons are organized into several departments, each with its own department head who is responsible for organization, training, personnel assignments, departmental planning and operations,

security, safety, cleanliness of assigned areas, and maintenance of records and reports. Just as in ships, the number and functions of departments vary somewhat according to the squadron's mission. Most squadrons have at least four departments: operations, administration, maintenance, and safety. Many have a training department as well.

Operations. This department is responsible for aircraft schedules, communications, intelligence, navigation, and (in squadrons without a separate training department) squadron training. Working for the operations officer are a number of assistants with special duties, including the communications officer, classified material security officer, intelligence officer, navigation officer, tactics officer, landing signal officer, and (in squadrons without a separate training department) several training assistants.

Administrative. The administrative department is responsible for official squadron correspondence, records maintenance, legal matters, and public affairs. An officer designated as first lieutenant ensures that squadron spaces and equipment are maintained and clean. Other assistants to the admin officer are the personnel officer, educational services officer, public affairs officer, legal officer, and command security manager. The personnel division takes care of personnel records, human-resources management, and equal-opportunity programs.

Maintenance. This department is typically the largest in the squadron and oversees the planning, coordination, and execution of all maintenance work on aircraft. It also is responsible for the inspection, adjustment, and replacement of aircraft engines and related equipment, as well as the keeping of maintenance logs, records, and reports.

Safety. The safety department head ensures squadron compliance with all safety orders and directives and is a member of the accident (investigation) board.

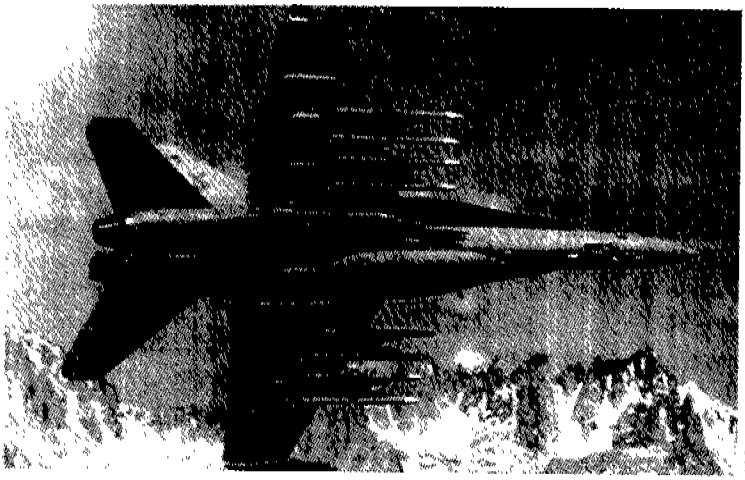
Training. Some squadrons have separate training departments to handle the training requirements of the squadron. Squadrons designated as *fleet replacement squadrons* (once known as readiness air groups or RAGs) exist to train new or returning squadron personnel in preparation for assignment to operational squadrons. Pilots and naval flight officers train in these squadrons after their initial basic flight training and before returning to an operational squadron after an extended assignment to other duties. Enlisted maintenance personnel are also trained in these squadrons in a special program known as FRAMP (Fleet Readiness Aviation Maintenance Personnel). Sometimes there is a separate FRAMP department.

15 Weapons

The Navy's overall mission is to maintain sufficient military capability to effectively deter a would-be enemy from using military power against the United States and its allies, to defend against any attacks that might occur, and to take offensive action against the enemy once hostilities have begun. Weapons are the mainstay of the military. Without them, the Navy could not carry out its combat missions or defend its ships, planes, bases, and personnel.

To understand the weapons used by the Navy, one should first be familiar with the following terms.

Ordnance. This term applies to the various components associated with a ship's or aircraft's firepower: guns, gun mounts, turrets, ammunition, guided missiles, rockets, and units that control and support these weapons.



U.S. Naval Institute

Figure 15.1. Without weapons, the Navy could not carry out its combat missions or defend its ships, planes, bases, and personnel.

Weapon system. When a number of ordnance components are integrated so as to find, track, and deliver fire onto a target, this is called a weapon system. For example, a gun would be called a weapon, but the gun plus the radars used to find and track the target and the ammunition-handling equipment used to load it would be called a weapon system.

Gun. In its most basic form, a gun is a tube closed at one end from which a projectile is propelled by the burning of gunpowder. A projectile (bullet) fired from a gun gets all of its traveling energy at the instant it is fired (unlike rockets and missiles whose burning fuels continue to propel them through the air).

Rocket. A weapon containing a propulsion section to propel the weapon through the air and an explosive section used to do damage to an enemy. A rocket is unable to change its direction of movement after it has been fired.

Missile. Originally called a "*guided* missile" this weapon is essentially a rocket (that is, it has a propulsion section and an explosive section), but also has a *guidance* section that allows its direction to be changed in mid-flight in order to better hit the target.

Torpedo. A self-propelled underwater weapon used against surface and underwater targets. Some torpedoes function like underwater rockets in that they cannot be controlled once they have been launched, while other, more sophisticated versions can be guided, like an airborne missile, after they have been launched.

Mine. An underwater explosive weapon put into position by surface ships, submarines, or aircraft. A mine explodes only when a target comes near or into contact with it.

Depth charge. Antisubmarine weapons fired or dropped by a ship or aircraft, and set to explode either at a certain depth or in proximity to a submarine.

Bomb. Any weapon, other than a torpedo, mine, rocket, or missile, dropped from an aircraft. Bombs are free-fall (that is, they have no propulsion power to deliver them to the target) explosive weapons and may be either "dumb" (unguided) or "smart" (with a guidance system to steer them to their target).

Missiles and Rockets

The Navy has a great many missiles and some rockets in its weapons inventory. The chief advantages of rockets and missiles over gun and bomb systems is their extended range, and missiles are, of course, more effective than rockets because of their increased accuracy. The

major disadvantage of these weapons is their added cost. Both missiles and rockets can be fired from either ships (including submarines) or aircraft.

Rocket and Missile Components

Rockets have three major components—the airframe, the powerplant, and the warhead. As already explained, missiles have a fourth component—the guidance system.

The airframe is the body of the rocket or missile which determines its flight characteristics and contains the other components. It must be light, because the other parts are heavy. Airframes are made of aluminum alloys, magnesium, and high-tensile (high-stress) steel. These metals can withstand extreme heat and pressure.

The powerplant is similar to the engines of an aircraft except that the aircraft's engines are reusable while the missile's propulsion unit is expended in its one flight. The powerplant must propel the rocket or missile at very high speeds to minimize its chance of being shot down before reaching its intended target. Some must be able to operate at very high altitudes where there is little or no atmosphere, and therefore are required to carry both the fuel and an oxidizer in order to sustain combustion. Other, less expensive powerplants are air-breathing plants that carry only the fuel, but they cannot operate above about 70,000 feet.

The warhead is the part that does the damage. Its explosive may be conventional or nuclear.

Missile Guidance Systems

The guidance system in missiles constantly corrects the flight path until it intercepts the target. There are four different types of guidance systems: inertial, homing, command, or beam riding. Many missiles use a combination of two of these systems—one guiding the missile through mid-course and the other used during the terminal stage.

Inertial Guidance

This type of guidance uses a predetermined path programmed into an on-board missile computer before launch. Missile speed and direction are checked constantly, and the computer makes corrections to keep it on course.

Homing Guidance

In this type of guidance, the missile picks up and tracks a target by radar, optical devices, or heat-seeking methods.

In an *active* homing system, the missile itself emits a signal that is reflected off the target and picked up by a receiver in the missile.

In a *semiactive* homing system, the signal comes from the launching ship or plane rather than from the missile itself and is then received by the missile which uses the information received to correct its flight.

A *passive* homing system does not require either the missile or the firing ship or aircraft to emit a signal, but uses the *target's* emissions to home in on. For example, some passive homers use a target's own radar signals to home on; a heat-seeking missile can home in on the heat put out by the target's engines.

Command Guidance

After the missile is launched on an intercept course, a computer evaluates how it is doing in relation to the target and transmits orders to the missile to change its track as necessary to ensure that it hits the target.

Beam-Riding Guidance

The missile follows a radar beam to the target. A computer in the missile keeps it centered within the radar beam. Several missiles may ride the same beam simultaneously. If the missile wanders outside the beam, it will automatically destroy itself.

Missile and Rocket Designations

Navy rockets and missiles are often identified by a three-letter designation, followed by a number. For example, the Sparrow missile is known as an AIM-7. The *A* tells you that the missile is launched from an airplane. If the first letter is an *R*, it means the missile is launched from a ship; *U* means that it is submarine-launched.

The second letter tells you the mission. *I* indicates air intercept (shoots down other aircraft), *G* means surface attack (ships or land targets), and *U* means the target is a submarine.

The third letter is either *M* (for missile) or *R* (for rocket).

The number(s) used differentiate between one similar system and another and represent the sequential development of the missile; for example, the first missile of a particular type that was developed was designated number *1* and the next was number *2*, and so on.

Missile Categories

Missiles can be launched from aircraft, ships, and submarines and, depending upon their intended target, may be categorized as air-to-

air, air-to-surface, surface-to-air, and so on. Some missiles can be used against air and surface targets alike.

Air-to-Air

Carried by naval aircraft to shoot down enemy aircraft, some of the current ones in use are listed below.

Sparrow. Designated the AIM-7, this highly maneuverable radar-guided missile can attack enemy aircraft from any direction in virtually all weather conditions and has a range of more than 30 nautical miles.

Sidewinder. The AIM-9 is an all-weather heat-seeking missile with a range of five to ten nautical miles depending upon conditions.

Phoenix. The AIM-54 is a highly sophisticated, radar-guided, long-range (more than 100 miles) missile that is fired only by the F-14 Tomcat fighter aircraft.

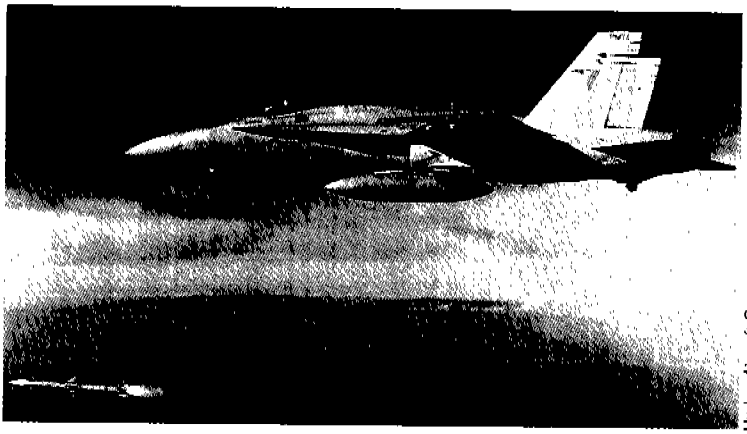
AMRAAM. The AIM-120 is a radar-guided sophisticated missile with a range of approximately 30 miles. "AMRAAM" stands for "*a*dvanced *m*edium-*r*ange *a*ir-to-*a*ir *m*issile."

Air-to-Ground

Despite the name, these missiles can be used against ships at sea as well as inland targets.

Shrike. Designated AGM-45, this missile is delivered by fighter aircraft and is designed to home in on enemy antiaircraft radars.

HARM. The AGM-88 is named for its capabilities as a "*h*igh-speed *a*nti*r*adiation *m*issile." It homes in on enemy radar-equipped air defense systems.



Hughes Aircraft Company

Figure 15.2. An F/A-18 Hornet fires an AMRAAM missile.

Maverick. The AGM-65 is an infrared-guided missile designed for day or night sea warfare (antiship) and land interdiction missions.

Surface-to-Air

Designed to shoot down incoming enemy aircraft and missiles, these weapons can be used in concert with or instead of friendly interceptor aircraft.

Standard. The missiles currently in use by the Navy are grouped together in several variations of what are called the Standard (RIM-66) missiles. The SM-1 MR (medium range) and SM-2 MR are two common variations. There is also an extended range version that is designated "ER" instead of "MR."

Sea-Sparrow. A modified version of the Sparrow air-to-air missile, this missile is carried by ships having no Standard missile capabilities. This missile has a range of about 10 nautical miles and is designed to provide close-in protection when other means of antiair defense have been ineffective.

Cruise Missiles

These missiles can be fired from surface ships to strike other surface ships and could therefore be called surface-to-surface missiles, but because they may also be fired from submarines or from aircraft to hit surface targets, they are more generically referred to as cruise missiles.

Harpoon. Because Harpoons can be fired from virtually every combatant in the Navy (surface ships, submarines, and aircraft) the Harpoon is designated as the RGM-84, the UGM-84, and the AGM-84. It has a range of 75+ miles and a version called SLAM (for *s*tand-off *l*and *a*ttack *m*issile) is used to attack land targets.

Tomahawk. The BGM-109 can be used in several variations, including a TASM (*T*omahawk *a*nti*s*hip *m*issile), a TLAM (*T*omahawk *l*and-*a*ttack *m*issile), and a TLAM(N) (nuclear) version. These missiles vary in range from 250+ nautical miles in the TASM version to 750+ nautical miles and 1200+ nautical miles in the TLAM and TLAM(N) versions, respectively.

Fleet Ballistic Missiles

With nuclear warheads capable of hitting multiple targets and doing massive damage, these missiles are designed for strategic deterrence and attack. They represent some of the greatest advances in modern weapons technology and can be launched from submerged submarines over a wide range of the earth.

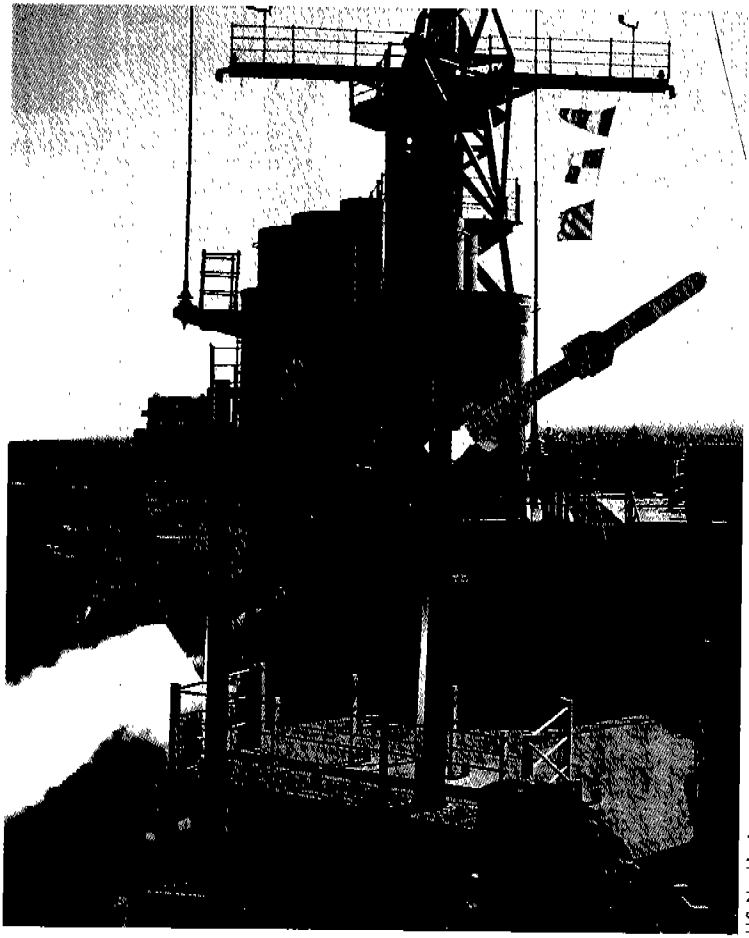


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Figure 15.3. A surface-to-surface Harpoon (RGM 8) is fired from a canister launcher aboard a destroyer.

Trident. These subsurface-to-surface missiles, in their most advanced version, the *Trident II,* have a range of more than 6000 miles and are capable of carrying up to eight independent thermonuclear warheads.

Missile Launching Systems

Earlier missile systems had "dedicated" launchers—separate magazine-loaded launchers for each type of missile. This took up valuable space on board ship and increased topside weight. Later launchers

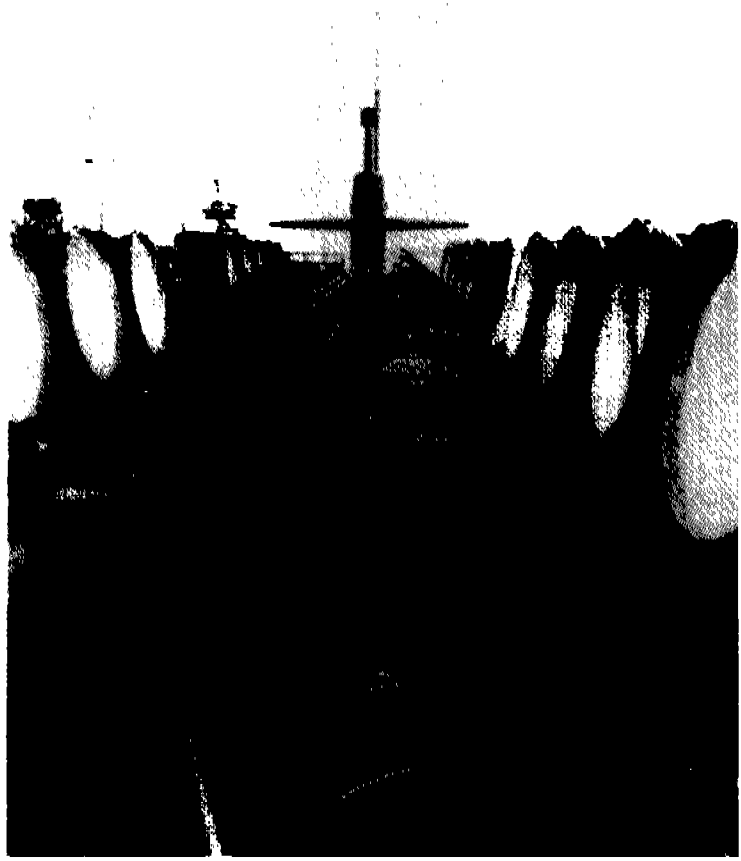

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Figure 15.4. On board SSBN submarines, Trident missiles are carried in vertical silos—here seen with their hatches open.

handled more than one type of missile, but still had to be individually loaded. The newest launcher is the Mark 41 VLS (vertical launch syctem), going into current *Ticonderoga-* and *Arleigh Burke*–class ships and being retrofitted into the *Spruance* class. Missiles are carried in below-deck ready-to-launch tubes; any needed mix of missiles can be fired right from these tubes in quick succession without the delays involved in reloading topside launchers.

Bombs

Bombs have four chief parts. The *case* is normally made of steel and contains the explosive. The *fuze* causes the bomb to explode when

desired. The *fin* or *tail assembly* stabilizes the bomb during flight. The *arming-wire* assembly keeps the fuze or fuzes from being armed until after the bomb is dropped.

Bombs are classed as explosive, chemical, or practice. *General-purpose* (GP) bombs, weighing 100–2000 pounds, are explosive-type bombs and are generally used against unarmored ships or ground targets for blast or fragmentation. *Semi-armor-piercing* (SAP) bombs are used against targets that are sufficiently protected so as to require the bomb to have some penetration capability in order to be effective. *Fragmentation* bombs are usually smaller explosives dropped in clusters against troops and ground targets.

Chemical bombs contain specialized chemical agents that are used for a specific purpose. They can contain chemicals that are designed to disable or kill enemy personnel—such as mustard gas, phosgene, tear gas, or vomiting gas—or they can be smoke bombs containing white phosphorus that ignites during the explosion and spreads heavy smoke over the target area in order to conceal movements of ships or troops. *Incendiary* or *napalm* bombs, containing a mixture of gasoline or jet fuel and a thickening agent, are a form of chemical bomb that produces intense fire when ignited and are used against troops and ground targets.

Practice and drill bombs used in training may be loaded with sand or water but are inert (carry no explosive) and will cause no damage other than simple impact.

Torpedoes

The torpedo is a self-propelled, explosive-carrying, underwater weapon. Early torpedoes were basically of the "point-and-shoot" variety, but modern versions have some sort of guidance system that markedly increases the accuracy of the weapon.

A torpedo consists of a tail, afterbody, midsection, and head. The tail section includes the screws, fins, and control surfaces. The propulsion system is contained in the afterbody. The midsection houses batteries, compressed air, or liquid fuel. The head contains the explosive charge, fuze, and any acoustic or magnetic sensing devices.

Torpedo guidance systems are either preset, wire-guided, or homing. Preset torpedoes follow a set course and depth after they are launched. Wire-guided torpedoes have a thin wire connecting the torpedo and the firing vessel, through which guidance signals can be transmitted to the torpedo to direct it to intercept the target.

Homing torpedoes are either active, passive, or a combination of active/passive. The active versions depend on the sensing signals generated and returned to the torpedo through a sonar device inside the torpedo. Passive types pick up tell-tale signals (such as noise or magnetic disturbances) to home in on. In the active/passive mode, the torpedo searches passively until a target is acquired, then active terminal guiding finishes the target destruction.

Surface ships launch torpedoes from tubes mounted topside, or propel them to the target area with a rocket called an ASROC (anti-submarine rocket). Submarines launch torpedoes through specially designed tubes, and aircraft deploy their torpedoes by parachute so as to reduce the impact when the weapon strikes the water.

Mines

Mines are passive weapons that are planted under the water to await the passage of enemy vessels to explode and do damage. Their advantage is that they operate independently (that is, no personnel are required to operate them once they have been planted). Their chief disadvantage is that they are indiscriminate (they can damage friendly or neutral vessels as well as enemy ones if precautions are not taken). You might be confused a bit if you read naval history and see the word "torpedo" used. In earlier times, what we now call a mine was called a torpedo. Today they are, of course, very different weapons.

Mines can be classified according to the method of actuation (firing), the method of planting, and their position in the water.

Mines may be actuated by contact and/or influence. A contact mine fires when a ship strikes it. Influence mines may be actuated by the underwater sound generated in a passing ship's current, by the ship's magnetic field, or by the mine's sensitivity to reduced water pressure caused by a passing ship.

Mines may be planted by surface craft, submarines, and aircraft. Planting mines using surface craft is the most dangerous method because the ship doing the planting is vulnerable to attack. Submarines can plant mines more secretly and aircraft are able to plant mines quickly and with less risk.

Moored contact mines are anchored in place and float near the surface of the water where a ship might strike them. Bottom mines, which lie on the ocean floor, are used only in relatively shallow water. They are influence mines, set off by sound, magnetism, or pressure.

Naval Guns

Guns have been a major component of naval armament for centuries. Early guns were highly inaccurate, often very dangerous devices that had to be loaded from the front end and aimed simply by pointing at a visible enemy. Today's guns are much more powerful and accurate, far safer, and aimed and controlled by sophisticated electronic and hydraulic systems.

Early cannons had smooth bores (inside the barrel) and usually fired round shot. Modern guns have *rifling* in their barrels which is a network of ridges (called *lands*) and grooves shaped in a spiral that causes an elongated projectile to spin on its long axis (much as a well-thrown football). This increases the range and accuracy of the gun.

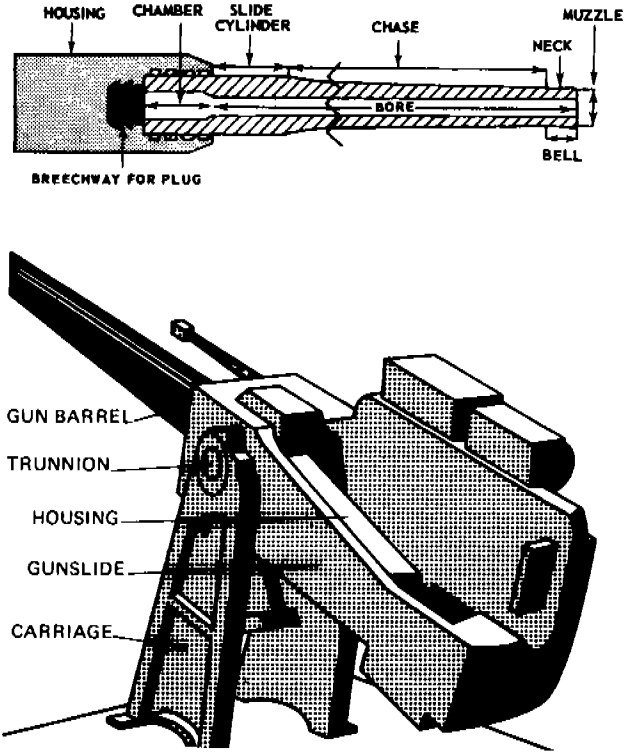

Figure 15.5. Some of the parts of a typical (simplified) naval gun.

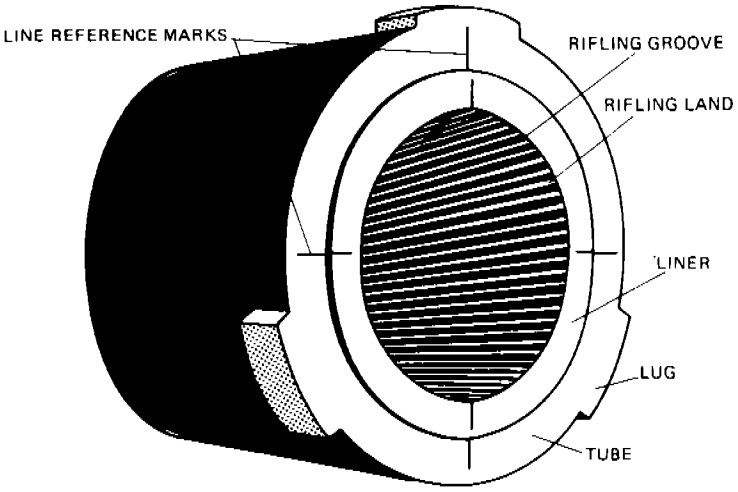

Figure 15.6. A view into the barrel of a naval gun shows the spiraling lands and grooves known as rifling.

Guns are not nearly as important to naval ships as they once were. The advent of sophisticated missile systems, with their greater range and superior accuracy, have taken the place of the gun as the mainstay of naval armament. There is, however, still a need for naval guns. Certain missions are better performed by guns, and missiles tend to be much more expensive than guns.

U.S. Navy guns are classified by their inside barrel diameter and by their barrel length. These two figures are expressed in a rather cryptic manner that may seem confusing at first, but makes sense once you understand what it is telling you. The first figure in a Navy gun classification is the inside barrel diameter, expressed in inches or millimeters (mm). The second part follows a slash and, when it is multiplied by the first number, tells you the length of the gun's barrel. Thus, a 5-inch/54 gun would have an inside barrel diameter of five inches and a barrel length of 270 inches ($5 \times 54 = 270$).

In years past, guns such as the 8-inch/55 and the 16-inch/50 were the main armament of large cruisers and battleships. Today, the most prevalent guns in the U.S. Navy are the 5-inch/54 (on cruisers and destroyers), the 76mm/62 (on frigates), and a specialized close-in weapons system (CIWS) known as the 20mm/76 Phalanx system (mounted on many ships as a protection against incoming missile

attacks). Many Navy ships also carry saluting guns, which are used for ceremonial purposes and have no combat capability.

Weapon Control Systems

A weapon, however powerful, is only as good as its accuracy. The process by which a projectile, missile, bomb, or torpedo is guided to its target is called weapon control. A potential target is first detected by a sensor (radar, sonar, or lookout). It is then evaluated, either by human judgment, or by computer, or by a combination of the two. If the target is evaluated to be hostile, a decision is made, according to prescribed weapons doctrine, whether or not to engage. If the target is to be engaged, the appropriate weapon is selected. All available information is assimilated to produce a weapon-control solution that will guide the weapon to contact. The weapon is then fired.

Weapon systems and their components are identified by a "Mark" and "Mod" (modification) system. A new weapon system may be designated the "Mark 22" system, for example. If it is later modified, the improved system would be called the "Mark 22 Mod 1" system.

Sensors

Before electronics arrived on the scene, enemies were detected and aimed at using the human senses, primarily the eyes. Modern weapons rely on electronic systems for detection of targets and to control weapons. Most common are *radar* and *sonar*. Both operate on the same principle but differ in the medium used.

In its most elemental form, radar (radio detection and ranging) uses a *transceiver* to send out (transmit) a radio-like electronic signal that reflects off a target and then returns the signal to a receiver where a very accurate timing system measures the amount of time that the signal took to travel to and from the target and, using the known speed of the signal, calculates the range to the target. A built-in direction-finding system also provides a bearing (direction) to the target.

Sonar works on the same principle, except that the signal used is *sound* rather than radio waves. Because radio signals work well in air and sound is more effective underwater, radar is used effectively in the detection of surface or air targets, but sonar is the sensor used in the detection of subsurface (underwater) targets.

Radar, sonar, and other Navy electronic equipments are identified by the joint electronics type designation system. This system was originally called the "Army-Navy nomenclature system" and still retains the prefix identifier "AN" (for "Army-Navy"). The rest of the

designation consists of three letters plus a number. Each letter tells you something about the equipment and the number is the series number. For example, using Table 15.1, you can see that the designation AN/SPY-1 describes a multifunction (*Y*) radar (*P*) that is installed on surface ships (*S*). It is the first in the series of this type of radar, hence the number 1. If another radar of this type is later developed, it will be the AN/SPY-2.

Systems

Ships, aircraft, and submarines all incorporate various types of weapon-control systems. Surface- and air-search radars have been continuously improved since World War II to detect high-performance targets at long ranges in any weather. The newer surface-ship control systems work with guns and missiles, and include radars and digital computers that can quickly acquire and track targets while directing shipboard weapons.

The Mark 86 fire-control system is used in destroyers and larger ships, while the lightweight Mark 92 system is used in missile frigates. The most sophisticated weapon system currently used in U.S. Navy warships is the *Aegis* system, a rapid-reaction, long-range fleet air-defense system capable of effectively handling multiple surface and air targets simultaneously. It includes the very capable AN/SPY-1 radar, a quick-reaction tactical computer for overall command control, a digital weapon-control system, and state-of-the-art guided-missile launchers. Found in *Ticonderoga*-class cruisers and

Table 15.1. Joint Electronics Type Designation System

Installation	*Type of Equipment*	*Purpose*
A Airborne	A Invisible light, heat, radiation	D Direction finder or reconnaissance
B Underwater (submarine)	L Countermeasures	E Ejection (e.g., chaff)
S Surface ship	P Radar	G Fire control
U Multiplatform	Q Sonar	N Navigation
W Surface ship and underwater	R Radio	Q Multiple or special purpose
	S Special	R Receiving, passive detection
	W Weapon related	S Search
	Y Data processing	W Weapon control
		Y Multifunction

Arleigh Burke–class guided missile destroyers, the Aegis system gives a force commander the capability of controlling all the surface and aerial weapons of an entire battle group in a multithreat environment.

The SQQ-89 surface-ship ASW (antisubmarine warfare) combat system is an integrated system for detecting, identifying, tracking, and engaging modern submarines.

Submarines and aircraft have their own control systems, similar in general principle to those used in surface ships.

Fleet ballistic missiles fired from submarines are controlled by a missile fire-control system, which is connected to the submarine's inertial navigation system. The navigation system keeps accurate track of the ship's position. When missiles are to be fired, the fire-control system takes current position data and quickly computes firing information to put missiles on the proper ballistic course. While in flight, the missile keeps itself on course with the aid of a built-in navigational system.

Small Arms

The Navy also uses a variety of small arms (pistols, rifles, shotguns, grenade launchers, and machine guns) for various purposes, including sentry duty, riot control, and landing parties.

Just as with larger Navy guns, small arms are differentiated by the inside diameter (bore) of the barrel. Like larger naval guns, this diameter may be expressed in either inches or millimeters, but unlike larger guns, small arms do not include a follow-on figure representing the length of the barrel [see previous section]. When the figure is in inches, it is referred to as "caliber" as in ".45-caliber pistol," but when it is expressed in millimeters, the term caliber is not used, as in "9-mm pistol."

Shotguns are an exception. They are usually differentiated by "gauge," which still refers to the bore but is defined as the number of lead balls of that particular diameter required to make a pound. For example, it would take twelve lead balls of the diameter of the 12-gauge shotgun to equal one pound; sixteen balls for the 16-gauge shotgun. This means that the 12-gauge shotgun has a larger bore than the 16-gauge, which seems backwards at first but makes sense when you think about it.

Any weapon with a bore diameter of 0.6 inches (.60-caliber) or less is called a small arm. The largest Navy small arm is the .50-caliber machine gun.

Small arms are considered to be "automatic" if holding down the trigger causes the weapon to continuously fire and "semiautomatic" if the weapon reloads automatically when fired but requires another pull of the trigger to fire off another round.

Some small arms you may encounter are identified by the Army system of terminology. An "M" preceding a number identifies a particular weapon, such as the "M14 rifle." Modifications are identified by a follow-on letter and number combination. For example, the M16 rifle has been modified twice as the M16A1 and M16A2 versions. Sometimes the Navy system of "Mark" (abbreviated "Mk") and Modification (abbreviated "Mod") is used, as in the "20-mm Mk 16 Mod 5 machine gun."

Pistols

One of the oldest weapons in the Navy inventory is the M1911A1 .45-caliber semiautomatic pistol. It is commonly (though erroneously) referred to as the "45-automatic." Because you must pull the trigger each time you fire a round, this pistol is *semi-automatic*. Its magazine holds seven rounds and it has a maximum range of a little over 1,600 yards but is usually effective only at about 50 yards. One of its chief advantages is stopping power—where a .38-caliber revolver can be just as lethal as the .45, the latter is more likely to knock a man off his feet, even one who is pumped up on adrenalin. This can be a major asset when dealing with a charging fanatic, for example.

The 9-mm M9 semiautomatic pistol is a similar weapon to the .45-caliber pistol. Slightly lighter in weight, it has a maximum range of 1,800 meters (1,962.2 yards) and an effective range of 50 meters (54.7 yards). A major advantage is that its magazine has a capacity of 15 rounds, more than double that of the .45 pistol.

The .38-caliber revolver has maximum and effective ranges similar to the .45 pistol, but is lighter in weight. This makes it more suitable for flight personnel. It has a six-round capacity and its relatively simple design makes it unlikely to jam.

The 9-mm pistol is the official replacement for both the .45 and .38 pistols, but you may find the latter weapons still in service at some commands.

Rifles

As mentioned earlier, there are two versions of the M16 rifle you may encounter—the M16A1 and M16A2. Both versions are magazine-fed weapons that fire a 5.56-mm (just slightly larger than a .22-caliber) round. The caliber may seem small, but the high muzzle velocity

(more than 3,000 feet per second) makes this a very powerful weapon. The M16A1 has a selector lever that allows the user to fire in automatic or semi-automatic mode, and the M16A2 has a similar selector that permits semi-automatic or burst (3 rounds) modes. The magazine capacity is either 20 or 30 rounds, depending upon the type used, and the maximum range is 460 meters (503 yards).

While the M16 is the replacement rifle for the Navy, you may still encounter some M14 rifles. Firing a 7.62-mm round in either automatic or semi-automatic mode, this was the last of the wooden-stock rifles before lighter, plastic ones appeared on the M16. Fully loaded, this rifle weighs in at 11 pounds and has a maximum range of about 4,075 yards.

Shotguns

The most common shotgun in the Navy is the Remington M870. Manually operated, this 12-gauge pump-action shotgun can fire 4 rounds without reloading. The Mossberg M500 is also a 12-gauge shotgun similar to the M870.

Machine Guns

The .50-caliber M2 Browning machine gun (abbreviated "BMG") is mounted on many surface ships and patrol craft for close-in defense. Ammunition is belt-fed at a rate of 450–500 rounds per minute. The BMG has a maximum range of 7,400 yards and an effective range of 2,000 yards. This is a highly effective weapon, but because it is air-cooled, there is the danger of a cook-off situation after a burst of 250 rounds or more; you should therefore always keep the weapon laid on target or pointed in a safe direction during breaks in firing. In an extreme case—called runaway firing—the BMG can actually continue firing after the trigger has been released. This can be remedied by twisting the ammunition belt at the feed slot to jam the weapon.

A lighter, but very effective machine gun is the 7.62-mm M60. With a maximum range of 3,725 meters (4,075 yards) and an effective range of 1,100 meters (1,200 yards), the M60 was originally designed for use by ground troops but has been adapted for naval use as well. Firing in short bursts is preferable to continuous firing to prevent overheating.

Grenade Launchers

You may encounter three different kinds of grenade launchers in the Navy. The 40-mm M79 is hand-held, like a shotgun, and fires one round (grenade) at a time. The Mk 19 Mod 3 machine gun is a

mounted weapon that fires multiple 40-mm grenades in fully automatic bursts. The M203 grenade launcher is actually an accessory that can be attached to the M16A1 rifle.

Safety Precautions

The following general safety precautions apply whenever you are handling any type of firearm:

1. Treat every weapon with respect. Consider it to be loaded even if you are certain it is not.
2. Always be aware of where the muzzle (open end of the barrel) is pointed. *Never point a weapon at a person unless you intend to shoot that person.*
3. Always make sure the bore (inside of barrel) is clear and that all oil and grease have been removed from the outside of the weapon before firing.
4. Use only the proper size of ammunition.
5. Unload firearms before transporting them unless they may be needed during the transit.
6. Keep the safety on until you are actually ready to fire the weapon.
7. Never shoot until you have positively identified the target.
8. Unload unattended weapons. If you have weapons at home, stow them with trigger locks installed and keep ammunition out of the reach of children.
9. Do not climb trees or fences with a loaded firearm if it can be avoided.
10. Do not pull a firearm toward you by the muzzle.
11. Be aware of the possibility of ricochet when firing. Keep in mind that a bullet may skip like a stone on water if fired at a shallow angle over a hard or liquid surface.
12. It should be obvious that firearms and alcohol don't mix. Be aware that many prescription drugs also have side effects that can add to the danger of handling weapons.
13. Know your weapon—its shooting characteristics, its safeties, and its loading and handling procedures.
14. Never play around when carrying a weapon.

Firing Techniques

When firing a small arm, whether on a target range or in an actual real-life combat situation, remembering some basic rules will help you to be more effective.

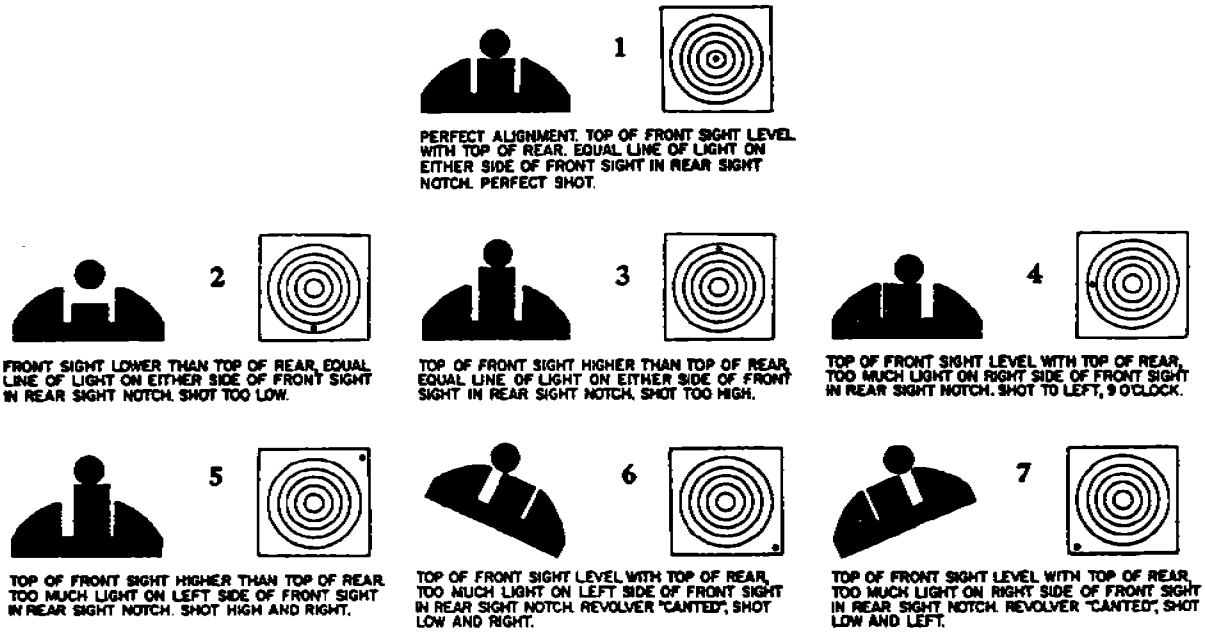

Figure 15.7. Effects of correct and incorrect small arms sight alignment.

Proper sight alignment is essential to accuracy. Although it may seem illogical to you, the point at which you are aiming should be resting on top of the two aligned sights. When aiming, you want the front and rear sights to be perfectly aligned and the target appearing to rest directly on top of them.

Blackening your sights will prevent glare. Use a smudge pot, carbide lamp, candle, cigarette lighter, or ordinary match to blacken your sights.

Take a normal breath before firing, exhale part of it, and hold the rest as you squeeze the trigger. Squeeze the trigger steadily—do not jerk it. If your sight alignment shifts while you are squeezing, do not release the pressure on the trigger; hold it while you realign the sights, then continue squeezing. You should be surprised when the weapon fires.

16 Shipboard Life

As a Sailor in the U.S. Navy, you will more than likely serve aboard ship. In previous chapters, you have learned some things about shipboard organization and routine. You know, for example, that each day's events are listed in the Plan of the Day (POD). You have learned that there are certain rituals regarding the national ensign and that ships have a commanding officer we traditionally call "Captain," a second in command whose title is executive officer or XO, and that each ship is organized into a variety of departments and divisions. In this chapter, you will learn more about the routine and the not-so-routine of shipboard life.

Standard Organization and Regulations of the U.S. Navy

If you had to learn a new set of regulations and an entirely different organization every time you moved from one division, department, or ship to another, you would waste a great deal of time and probably become very confused. The Navy has standardized everything—routine, regulations, and organization—as much as possible on all ships, so that transferring from one to another will require only minor adjustments on your part. The basis for this standardization is the current edition of the *Standard Organization and Regulations of the U.S. Navy* (OPNAVINST 3120.32). Your daily and weekly routine aboard ship will be governed by this book, no matter which ship you might serve in. (*Note:* You serve "in" a ship, not "on.") Your division and department will be organized in accordance with this manual, and the ship's governing regulations and instructions will have been drawn up using this book as the basis.

The various chapters of OPNAVINST 3120.32 deal with unit organization, safety, training, maintenance, and administration, and you would do well to familiarize yourself with each of these.

General Guidance and Regulations

Chapter 5 of OPNAVINST 3120.32, entitled "General Rules and Regulations," spells out those regulations that are common to all Navy ships, most of which will apply directly to you. For example, it contains rules concerning the proper operation of the ship's general announcing system (1MC), telling you that you must never use the 1MC without permission from the OOD. In chapter 5, you will also find that:

- Alcohol must never be consumed aboard a Navy ship except when authorized for medicinal purposes.
- Wearing shoes while in a berth (bed) is forbidden.
- Gambling is illegal.
- Nothing is to be sold aboard ship except in the ship's store.
- Any electrical appliances brought on board must be approved by the ship's electrical officer.
- Fresh water must be conserved.
- Government property may not be removed from the ship without permission.
- Any communicable disease you have (or *think* you have) must be reported.
- Intoxication may lead to restraint.
- Red lights are the only lights authorized in certain areas at night (to preserve night vision for watchstanders).
- Cups, silverware, and other materials must not be removed from the mess decks.
- Ship's parties and other social events or celebrations must not glorify or encourage the consumption of alcohol, include sexually suggestive activities, or show disrespect to religious beliefs.
- Frayed, torn, dirty, or otherwise mutilated clothing is prohibited.
- Paint and other flammable substances must be properly stowed.
- Pets are not allowed without permission of the commanding officer.
- Nothing should be thrown overboard without permission.
- Swimming over the side of the ship is not permitted without permission from the commanding officer.
- Personal mail may be subject to censorship for security reasons.
- Specific routes must be followed when going to battle stations (if you must go forward or up, do it on the starboard side of the ship; use the port side to go aft or down).

These are not all of the regulations discussed in chapter 5, and because you will be held accountable for all applicable ones, you should make certain that you read and understand them.

Unit Bills

Another important feature of OPNAVINST 3120.32 is found in chapter 6, which describes the various bills used to assure that the required stations are manned for all important evolutions. Once these bills are set up on your ship, they tell you where you are supposed to be and what your duties will be for a given evolution. For example, the man overboard bill tells you where you are supposed to go and what you are supposed to do if anyone falls off the ship. If your ship is headed for some bad weather, the heavy weather bill explains who does what in order to prepare. Quite a few bills are listed and explained in chapter 6 to cover virtually every contingency, but not all of them apply to every type of ship. The unit bills covered in chapter 6 may be used as written or may be used as a guide in writing bills tailored for a specific ship.

The bills in chapter 6 are grouped according to the function they provide and are included as either administrative, operational, emergency, or special.

Administrative Bills

Included in this group are the bills that take care of routine functions in the daily administration of the ship. Some of the bills found in this section are listed below.

Berthing and locker bill. This bill ensures that you and all your fellow crew members have a place to sleep and to stow clothing and other personal effects.

Cleaning, preservation, and maintenance bill. Procedures for cleaning and preservation (such as painting and lubricating) are provided so that department heads and division officers can make the appropriate personnel assignments.

Formation and parade bill. Identifies the areas of the ship to be used for various formations, such as morning quarters, personnel inspection, quarters for entering and leaving port, and ceremonial manning of the rail. Both fair- and foul-weather plans must be drawn up for many of these evolutions.

General visiting bill. Used to specify procedures for controlling visitors to the ship, ensuring adequate security for the ship and safety of the visitors.

Orientation bill. Designed to provide an indoctrination program for newly reporting personnel, this bill calls for briefings and/or

counseling on the ship's history, mission, organizations, regulations, routine, current operating schedule, and a wide variety of other topics.

Zone inspection bill. Under the guidance of this bill, the ship is divided into zones small enough to allow an experienced officer to conduct a thorough inspection in a reasonable amount of time. Zone inspections are conducted at least quarterly and each zone has a senior officer (ideally a department head) assigned on a rotational basis to ensure a fresh look at the zone each time.

Other administrative bills include the official correspondence and classified material control bill, the personnel assignment bill, the personnel recall bill, and several types of security bills.

Operational Bills

These bills cover a wide variety of operations that a ship may conduct as part of its mission, such as operating the ship's boats, launching and recovering aircraft, fueling helicopters while they are hovering above your ship, collecting intelligence, defending the ship against attack while it is in port, preparing for heavy weather, operating in extreme cold, navigating under various circumstances, replenishing supplies while underway, rescuing individuals or other vessels in distress, putting divers in the water, performing salvage operations, and towing other vessels. Some of the other bills of special interest are discussed below.

Darken ship bill. When ships steam at night all unnecessary lights must be extinguished for navigational safety (and to avoid enemy detection in war). When darken ship is set, all topside doors and hatches are closed and ports are blacked out. To perform efficiently during darken ship, you must be able to find your way around the ship's topside in complete darkness and know how to open and close doors, plug in telephones, locate switches, and handle all other equipment at the underway or general-quarters station. During darken ship, only flashlights or hand lanterns with red lens covers can be used topside, and only when absolutely necessary.

Dry-docking bill. On occasion, ships need to come out of the water in order to allow major repairs to their hull, rudder, propellers, or other underwater fixtures. This is accomplished by putting the ship into a special dock that can be pumped dry, leaving the ship perched on special blocks so that workers can get to her underside. This is obviously a delicate operation that must be accomplished without error. The ship's dry-docking bill establishes the procedures and ensures that all personnel involved know what needs to be done.

EMCON bill. Enemy forces with the right kind of equipment can locate your ship by picking up and homing in on the ship's emitters (equipment that puts electronic signals into the air, such as radar and radio). To counter this, the ship will have an emission control (EMCON) bill, which will ensure that the ship's emitters are turned off or very tightly controlled when the threat of enemy detection is a concern.

Equipment tag-out bill. Common sense dictates that you must turn off the power before you work on a piece of electrical or electronic equipment, but aboard ship the power cutoff switch may be located some distance from the equipment it serves. The same is true for steam lines, fluid lines, and other potentially dangerous systems found aboard modern ships. Sometimes, for safety reasons, it is essential to turn off equipment you are not even working on; for example, if you are going up on the mast to change the bulb of the ship's masthead light, it is vital to turn off the radars and transmitting radio antennas to keep you from being harmed by them. The last thing you want to happen is for someone to turn on a piece of equipment accidentally or open a valve that presents a hazard to you. To prevent such accidents, ships employ equipment tag-out procedures, which involve labeling all secured components, making periodic announcements over the ship's general announcing (1MC) system, and ensuring interdepartmental coordination and cooperation.

Special sea and anchor detail bill. When ships get underway or return from sea, many more people must man stations and perform tasks not necessary during routine steaming. For example, the ship's anchors must be manned (either actually to anchor the ship or to be ready in case of an emergency) whenever the ship enters shallow water. This bill provides the organization necessary to ensure that the ship is properly manned and ready for safe navigation when entering or leaving port.

Emergency Bills

The nature of life at sea and the dangers encountered in wartime create the need for advance preparation for a wide variety of emergencies. The emergencies covered in this section of chapter 6 of OPNAVINST 3120.32 include aircraft crash and rescue, man overboard, nuclear-reactor casualties, nuclear-weapon accidents, and encounters with toxic gas.

The *jettison bill* is used when the ship's stability is threatened and can only be improved by throwing overboard (called jettisoning) heavy items, particularly those located high in the ship. For example,

a fire, collision, or some other disaster on an aircraft carrier may result in the ship taking on large quantities of water, which threatens stability. By throwing aircraft and flight-deck tractors off the flight deck the situation can be improved.

Because steering is so vital to a ship (besides the obvious reasons, losing the ability to steer in a heavy storm can result in a ship capsizing), the crew must be able to improvise with emergency steering measures when the time comes. The *emergency steering bill* sets up the procedures for contending with this emergency.

Special Bills

Several bills that do not fit into the other categories are listed as special bills.

Antisneak/antiswimmer attack bill. When ships are in foreign ports, particularly during times of crisis or war, it is prudent to defend against sneak attacks. Because ships are particularly vulnerable to underwater attack by swimmers, extra measures of security must be employed to prevent such attacks.

Evacuating civilians bill. Crisis situations such as foreign wars or natural disasters sometimes require civilians to be evacuated. Because U.S. Navy ships are deployed to many parts of the world, they are often the most efficient means of carrying out evacuations. This bill provides the guidance for preparing for such a contingency.

Prisoners of war bill. Should your ship be involved with the taking or transport of enemy prisoners of war, this bill establishes the procedures required in this unusual situation.

Strip ship bill. During battle, many items found aboard ship during peacetime conditions can become very hazardous. Certain flammable materials in particular may be perfectly safe for shipboard use during normal conditions, but under combat conditions greatly enhance the ship's chances of sustaining lethal damage. The strip ship bill establishes procedures for removing these items in a methodical and logical manner.

Troop lift bill. Should your ship be required to transport troops from one place to another, this bill will help your ship properly organize for the task.

Watch, Quarter, and Station Bill

Most significant of all the bills found in your ship is the watch, quarter, and station (WQ&S) bill. This bill is prepared by your division officer and summarizes the personnel assignments within the division, based upon the other unit bills and the actual people assigned to

the division. You should know where this bill is posted and be very familiar with those parts that apply to you. Your name will actually appear on this bill and it will list your responsibilities under various conditions.

Some ships are equipped with a computer-generated system called the shipboard nontactical ADP (automated data processing) program (SNAP), while others continue to use the old WQ&S manual system, which uses a bulletin board–size chart to list all the required stations and the people who are assigned to them.

By referring to the WQ&S bill, you will see your bunk and locker number, your cleaning station, your in-port and at-sea watch assignments, your assignments during special situations covered by other unit bills (such as fire, collision, or rescue and assistance) and what you are supposed to do during various readiness conditions (explained below).

Shipboard Duties

As you have probably gathered from the previous discussion, life aboard ship has many aspects. Some days you will primarily be doing cleaning and maintenance tasks, while others will find you taking part in evolutions such as entering and leaving port, refueling, receiving a helicopter, providing gunfire support, rescuing victims of some natural disaster, or any number of other activities that Navy ships take part in around the world. Your day may very well also include standing a routine watch or two, and training is an ever-present part of shipboard life.

Maintenance

Just as a car must receive periodic maintenance in order to keep functioning at peak efficiency, a ship and all of its many types of equipment must be maintained in order to meet all the challenges that may come along in both peace and war.

Broadly speaking, maintenance is either *preventive* or *corrective*. Preventive maintenance forestalls equipment or material failure. It includes such things as inspecting, cleaning, painting, lubricating, and testing. Corrective maintenance is another name for repair and becomes necessary when a piece of equipment fails or some part of the ship needs to be fixed. Such things as replacing worn-out parts in a piece of machinery, patching holes in the hull of one of the ship's boats, or rewiring an electronic component would be examples of corrective maintenance.

Because of the Navy's size and complexity, and the variety of equipment that must be maintained for ready use, a carefully planned program is required. The program must be the same for all equipment of the same type, regardless of the type of ship or location, so that a person transferred from one location to another can take on a new task easily. The Navy has such a program, called the 3-M (maintenance and material management) system.

Compartment Responsibility

Every compartment on a ship is assigned to a particular division for cleaning and maintenance responsibilities. While the responsible division officer will be aware which spaces have been assigned to her or him, it is important to have some means by which anyone can find out which division is responsible for a given space. On an aircraft carrier, for example, there are hundreds of compartments and the executive officer may not be able to remember who is responsible for every space, but in his or her travels about the ship he or she may be disappointed in the condition of one of the passageways. You may be going from one deck to another through a ladder well and notice that the nonskid surface is peeling up on one of the ladder rungs, creating a safety hazard. The carrier XO and you need an efficient system for finding the responsible division to report your findings.

This basic but important need is met by a system of compartment responsibility markings. Every compartment on every ship in the Navy is required to have one of these markings. It consists of a 12-by 15-inch rectangle painted with photoluminescent paint (so that it can be easily found in low-light conditions) with two-inch black letters stenciled in its center. It should, whenever possible, be located at eye level where it can easily be seen. The information placed in this rectangle is standard throughout the Navy.

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The first line tells you the compartment number (see "Deck and Compartment Identification" in chapter 12). The second line tells you the extent of the compartment in terms of how many frames it spans, and the last line tells you which division is responsible for the space.

Damage-Control Function. The subject of damage control is treated in some detail in chapter 18, but it is important to note here that the compartment-responsibility marking system serves another

important function besides telling you which division is responsible for a particular space. It also serves to identify the compartment quickly so that anyone can report it in the event of a fire or other emergency. If you discovered a fire in this space, you could report it without confusion, even if you had never been to this space before and were not familiar with it. By reading its number off the first line, you could tell the damage-control party exactly where they needed to go to fight the fire. This saves valuable time, which would be especially essential in the example used above since the space identified in this example is a magazine used for stowing ammunition!

Finding Your Way. The compartment-identification marking serves one more important purpose. It can help you find your way around the ship by serving as a kind of street-sign system. Again referring to chapter 12, you know that the first number in the first line tells you what deck you are on; the second tells you the frame number of the compartment (so if you begin walking and the next compartment you enter has a higher frame number, you know you are heading aft); and the third number in the first line tells you which side of the ship you are on (even numbers indicate the port side and odd numbers are for starboard). Using this information as you travel around the ship, you can never get too lost—even on a giant aircraft carrier.

The Maintenance and Material Management (3-M) System

As already mentioned, the Navy has standardized much of its maintenance requirements with the maintenance and material management (3-M) system. This system establishes service-wide maintenance procedures so that you can maintain a piece of equipment using the same procedures no matter what ship you may be serving in. This system also standardizes the *scheduling* of maintenance so that it is the same everywhere you go. It also allows for the standardized collection of data, which is useful in analyzing the reliability of specific equipments and thereby leads to the improvement of maintenance scheduling and procedures. The two main features of the system with which you will be concerned are the planned maintenance system (PMS) and the maintenance data system (MDS).

Planned Maintenance System (PMS). PMS is designed to standardize and simplify maintenance procedures. It defines types of maintenance, sets up maintenance schedules, prescribes the tools and methods used for a particular type of maintenance, and helps you detect and prevent impending casualties. PMS also provides a good foundation for training in equipment operation and maintenance.

This portion of 3-M also gives shipboard department heads the means to manage, schedule, and control the maintenance of their equipment. There are three major components of PMS: the PMS manual, maintenance schedules (cycle, quarterly, and weekly), and maintenance requirement cards (MRCs).

You will probably use MRCs almost daily. Your work center will have a complete set of them. When the weekly schedule names you for a job, pull the appropriate MRC from its holder and take it with you for step-by-step guidance while performing your task. The MRC has a periodicity code that tells when or how often a job is done (see Table 16.1).

If the MRC indicates a "related maintenance," it means there are two jobs and that they should be done together to save time. Safety precautions are listed for each job. Make sure you read, understand, and observe all precautions. The word "Caution" on an MRC means that a careless worker can damage the equipment; "Warning" means that the equipment could injure the worker. The section labeled "Tools, parts, materials, and test equipment" tells you exactly what to use. Don't substitute without authorization. If a particular grease is called for but not available, don't use just any grease. Check with your supervisor to see if there is an approved substitute.

Table 16.1. Periodicity Codes for Maintenance Requirement Cards

MRC	*Periodicity Codes*
D	Daily
2D	Each second day
3D	Each third day
W	Weekly
2W	Each second week
M	Monthly
2M	Each second month
Q	Quarterly
A	Annually
18M	Each 18 months
24M	Each 24 months
C	Cycle[a]
R	Situational[b]

[a]Cycle means that the designated maintenance is to be done once between major overhauls (approximately three years).

[b]Situational requirements would include such things as "before getting under way" or "after firing the guns."

Maintenance Data System (MDS). MDS is a management tool used by systems commands and fleet and type commanders to identify and correct maintenance and logistics support (supply) problems. This system has resulted in improvements in maintenance procedures, equipment design, the allocation of resources, and long-range cost accounting.

MDS is a means of recording planned and corrective maintenance actions. All maintenance actions, except daily and weekly preventive maintenance and routine preservation, are recorded in substantial detail using the MDS system. Recorded information concerns the number of man hours required to make a repair, materials used, delays encountered, reasons for delay, and the technical specialty or activity involved. Once this data has been submitted using MDS forms and procedures, the information gathered is used to improve PMS and supply procedures and can result in modifications to or replacement of equipment. The amount of time you spend recording information for the MDS system will be worthwhile because it is extremely valuable to those who must make important decisions on how to spend the Navy's money and how to improve equipment and procedures that will affect you and the others who must do the maintenance and operate the Navy's equipment.

Cleaning

The most basic form of preventive maintenance is cleaning. It is also the least glamorous of the many duties you will perform while living aboard ship, but this function is just as vital as anything you will do. You may have heard the term "shipshape" used to describe something that is clean and well organized; this term did not come into the English language by accident. A dirty or improperly maintained vessel will not function at peak efficiency and will create psychological as well as material problems that can mean the difference between victory and defeat when the time comes for the crew to perform under difficult circumstances.

Ships, by their very nature, cannot hire out to professional cleaning services, nor can they afford the luxury of having cleaning specialists in the crew whose only function is to do the cleaning. Therefore, the responsibility for cleanliness falls upon the crew, and these duties must be carried out in addition to other responsibilities that come with being a Sailor aboard ship.

As already discussed, the WQ&S bill will include your routine cleaning assignments so that you will know what your responsibilities are in this area. This does not mean that what is listed in the

WQ&S will be your *only* cleaning assignments. You may be given additional assignments from time to time by persons senior to you.

Sweepers

One of the routine evolutions you will encounter aboard every Navy ship is "sweepers." Shortly after reveille, at the end of the regular working day, and at other times as necessary, the word is passed on the ship's 1MC for sweepers. At these times, all men and women assigned as sweepers draw their gear, sweep and/or swab (mop) their assigned areas, and empty trash receptacles. If you are assigned as a sweeper or are placed in charge of a sweeper detail, make certain that trash and dirt are always picked up in a dustpan, never just swept over the side. Besides the potential environmental impact, sweeping dirt and trash over the side may result in the wind blowing it back on board, or it may stick to the side, giving the ship an unsightly appearance.

Compartment Cleaners

If you are assigned duty as a berthing-compartment cleaner, you will be responsible for keeping the compartment scrupulously clean. This may not be the most exciting or the most glamorous duty you will perform in the Navy, but it is extremely important. The close living conditions aboard ship make cleanliness not only desirable but absolutely essential. Few things can affect the combat effectiveness of a unit more than the spread of communicable disease, and unpleasant living conditions can have serious effects upon morale.

Topside Surfaces, Decks, and Deck Coverings

Topside surfaces, because of their constant exposure to weather and sea spray, must be kept clean in order to minimize the need to remove rust and other forms of corrosion. It is a lot easier and more economical to sweep and swab a deck than it is to remove rust and old paint and then repaint it.

There will be many inclement days at sea when weather and sea conditions prevent the crew from cleaning topside surfaces, but at the first opportunity these should be cleaned with fresh water and inspected for signs of rust and corrosion. If you see the beginnings of rust or signs of corrosion (aluminum surfaces, for example, will develop a white powdery residue in the early stages of corrosion), tend to the area immediately. A little work in the beginning will save a lot of work later.

Besides painting to prevent corrosion, decks are often covered with various other substances for a variety of reasons. For example,

nonskid materials are often applied to decks or ladder steps to prevent slipping, and decks near electronic equipment are frequently covered with special rubber matting to minimize the hazard of electrical shock. Deck coverings receive more wear than any other material and must be replaced early and at great cost unless proper care is given.

You will frequently encounter tile on decks inside the skin of the ship. The tile used in the Navy is more resilient and prevents fewer hazards than many forms you may have encountered in other walks of life (pun not intended). Tile-covered decks are kept up by sweeping loose dirt daily and wiping away spills as soon as possible. Frequent clamp-downs (cleaning with a wet swab) are important to prevent the buildup of unwanted substances. After a clamp-down, allowing the deck to dry and then buffing it with an electric buffing machine will improve the deck's appearance. For a more thorough cleaning when the deck is unusually dirty, apply a solution of warm water and detergent with a stiff bristle brush or circular scrubbing machine. Use water sparingly. Wet the deck with the cleaning solution, but do not flood it. Remove the soiled solution with a swab and rinse with clean water to remove residual detergent. Stubborn dirt and black marks left by shoes can be removed by rubbing lightly with a scouring pad, or fine steel wool, or a rag moistened with mineral spirits.

Waxing will greatly improve the appearance of a tiled deck but it should not be done to excess and should never be done when the ship is going out to sea or when heavy weather is anticipated. This is an added precaution against slipping, even though approved emulsion floor waxes are designed to be slip-resistant.

When rubber matting needs cleaning, it should be washed with a detergent solution, rinsed with a minimum amount of water, and dried.

Static conductive linoleum is ordinarily used as a deck covering in the medical operating room. This material should be cleaned in the same way as resilient deck covering, except that wax, oil, and polish should be avoided. These substances act as insulators and reduce the electrical conductivity of this type of deck covering. The deck's gloss may be increased by buffing lightly with fine steel wool and a floor-polishing machine.

Nonskid paint should be cleaned with a solution of one pint detergent cleanser and five tablespoons dishwashing compound or ten tablespoons of a substance called "metasilicate." This preparation is diluted with fresh water to make 20 gallons of solution. Apply with a hand scrubber, let it soak for five minutes, then rinse with fresh

water. Nonskid deck coverings should never be waxed or painted; otherwise their nonskid properties will be reduced.

Field Day

Periodically, a field day is held. Field day is cleaning day, when all hands turn to and clean the ship inside and out, usually in preparation for an inspection by the captain or his representatives. Fixtures and areas sometimes neglected during regular sweepdown (such as overhead cables, piping, corners, spaces behind and under equipment) are thoroughly cleaned. Bulkheads, decks, ladders, and all other accessible areas are scrubbed; the "knife edges" around watertight doors and their gaskets are checked, and any paint, oil, or other substances are removed; brightwork is shined; and clean linen is placed on each bunk. Field days improve the ship's appearance and sanitary condition, preserve her by extending paint life, and reduce the dirt around equipment. Besides the obvious effects that dirt can have on health, appearance, and morale, accumulated dirt can cause sensitive electronic equipment to overheat and can cause serious abrasion problems for moving parts on machinery.

Preservation

One of the most effective means of preventive maintenance is what we call "preservation." Preservation may be accomplished in a number of ways, such as applying protective grease to machinery parts that are subject to corrosion or lubricating moving parts to reduce abrasion. Simple cleaning procedures are a basic form of preservation, but the most common method of preserving the surface areas of ships is painting. Whether your stay in the Navy is one enlistment or a full 30-year career, and no matter what your rating, chances are you will be expected to paint something at some time. The old saying, "If it moves, salute it; if it doesn't, *paint* it," is more humor than fact but it contains a kernel of truth. Paint is vital because it seals the pores of wood and steel, arrests decay, and helps prevent rust. It also promotes cleanliness and sanitation because of its antiseptic properties and because it provides a smooth, washable surface. Paint is also used to reflect, absorb, or redistribute light. And, properly applied, it can improve the appearance of things markedly.

Despite all of its advantages, paint that is improperly applied can cause many problems. Proper painting is a skill that must be learned. While experience is the best teacher, there are procedures and methods that you can learn to prepare yourself for the challenges of becoming a skilled painter. Before painting, you must be able to

select suitable paints for the surfaces to be covered and you must know how to effectively prepare those surfaces. Then you must learn the correct methods of actually applying the paint.

Types of Paint

Different surfaces require different kinds of paint. Different conditions (for example, whether the area will be exposed to water or air) will also dictate the kind of paint compounds that are to be used.

Primers. Primers are base coats of paint that adhere firmly to wood and metal, providing a smooth surface for finishing coats. They also seal the pores. Those applied on steel are rust inhibitors as well. At least two coats of primer should be used after the surface is cleaned to a bright shine. A third coat should be added to outside corners and edges. At least eight hours' drying time should be allowed between primer coats.

Exterior Paints. The ship's bottom (part that is underwater all of the time, except when the ship is in drydock) is painted with two special kinds of paint. *Anticorrosive* paint inhibits rusting and *antifouling* paint slows down the attachment and development of marine growth (popularly known as "barnacles"), which if allowed to grow can slow down a ship considerably. Remember that antifouling goes on *after* anticorrosive paint. The latter, if allowed to come into direct contact with the hull, will cause pitting.

The waterline area, which is sometimes under water and sometimes exposed to air, is called the "boot topping" and is painted black with a special paint compound.

Vertical surfaces above the upper limit of the boot topping are given two coats of haze gray. Horizontal surfaces are painted with exterior deck gray, which is darker than haze gray. The underside of deck overhangs are painted white.

A nonskid deck paint is used on main walkways. It contains a small amount of pumice, which helps to give a better footing.

The top of stacks and top hamper, subject to discoloration from smoke and stack gases, are painted black.

Interior Paints. Depending on the use to which individual compartments are put, several color schemes are authorized or prescribed for interior bulkheads, decks, and overheads. Some spaces may be painted at the discretion of the individual ship, but many areas must be painted as prescribed by Naval Sea Systems Command (NAVSEASYSCOM). Deck colors, for example, are dark green in the wardroom and officers' quarters, dark red in machinery spaces, and light gray in enlisted living spaces. Common bulkhead colors are

green for offices, radio rooms, the pilot house, and medical spaces; gray for the flag plot, combat information center, and sonar control; and white for storerooms and sanitary and commissary spaces. Overhead colors are either the same as bulkhead colors or white.

Others. Many other types of paints are used for special purposes in the Navy. Aluminum surfaces require special primers and outer coats. Canvas preservatives, antisweat coating systems, varnishes, machinery paints, and many others are used aboard ship for different purposes. Never paint a surface without making certain that you have selected the correct paint. When in doubt, ask.

Surface Preparation

For paint to adhere to a surface, all salt, dirt, oil, grease, rust, and loose paint must be removed completely, and the surface must be thoroughly dry.

Salt and most dirt can be removed with soap or detergent and fresh water. Firmly embedded dirt may require scouring with powder or with sand and canvas. Do not use lye or other strong solutions because they might burn or soften the paint. When oil and grease fail to yield to scrubbing, they must be removed with diesel oil or paint thinner, and extreme caution is necessary. If you use diesel oil, scrub the surface afterward to remove the oil. After scrubbing or scouring, rinse the surface with fresh water.

To remove rust, scale, and loose paint, you need hand tools or power tools, paint and varnish removers, or blowtorches. Hand tools are usually used for cleaning small areas; power tools are for larger areas and for cleaning decks, bulkheads, and overheads covered with too many coats of paint.

Hand Tools. The most commonly used hand tools are sandpaper, steel wire brushes, and hand scrapers.

Sandpaper is used to clean corners and feather paint. Paint will adhere best to a clean surface that has been lightly sanded. A wire brush is useful for light work on rust or light coats of paint. It is also used for brushing weld spots and cleaning pitted surfaces.

Scrapers are made of tool steel, the most common type being L-shaped, with each end tapered to a cutting edge like a wood chisel. They are most useful for removing rust and paint from small areas and from plating less than one-quarter-inch thick, when it is impractical or impossible to use power tools.

Occasionally, it is necessary to use a chipping or scaling hammer, but care must be taken to exert only enough force to remove the paint. Too much force dents the metal, resulting in the formation of high

and low areas. In subsequent painting, the paint is naturally thinner on the high areas. Consequently, thin paint wears off quickly, leaving spots where rust will form and eventually spread under the good paint.

Power Tools. The most useful power tool is the portable grinder. It is usually equipped with a grinding wheel that may be replaced by either a rotary wire brush or a rotary cup wire brush. Light-duty brushes, made of crimped wire, will remove light rust. Heavy-duty brushes, fashioned by twisting several wires into tufts, remove deeply embedded rust.

Scaling may be done with a chisel and pneumatic hammer. When using this tool, you must take care that the chisel strikes the surface at approximately a 45-degree angle.

The rotary scaling and chipping tool (commonly called a "deck crawler") is particularly helpful on large deck areas.

The electric disk sander is another handy tool for preparing surfaces. However, great care must be exercised in its use. If too much pressure is applied, or if the sander is allowed to rest in one place too long, it will quickly cut into the surface, particularly wood or aluminum.

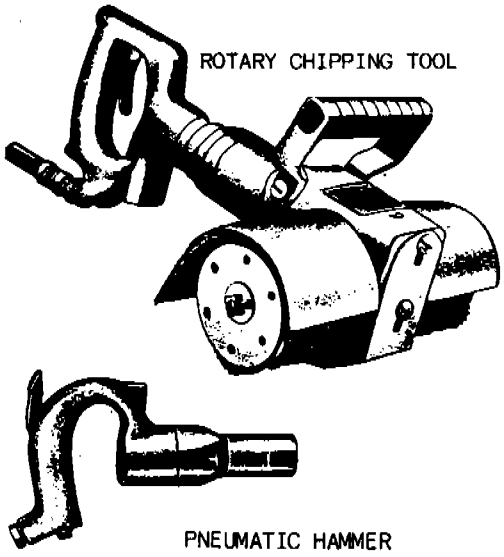


Figure 16.1. The rotary chipping tool (more commonly called a "deck crawler") and the pneumatic hammer are useful tools for removing paint from decks and bulkheads.

Figure 16.2. A Sailor using a disk sander aboard ship.

Paint and Varnish Removers. Chemical paint and varnish removers are used mostly on wood surfaces but may be applied to metal surfaces that are too thin to be chipped or wire-brushed. Three types of removers are in general use: flammable, nonflammable, and water-base alkali. All three are hazardous, and safety precautions must be observed. These chemicals should be used only in well-ventilated spaces. Alkali remover is not to be used on aluminum or zinc because of its caustic properties.

Procedures for using these chemical removers are the same regardless of type. Wet the surface with a smooth coat of remover. Permit it to soak in until the paint or varnish is loosened, then lift the paint off with a hand scraper. After the surface is cleaned, wet it again with the remover and wipe it off with a rag. Finally, wash the surface thoroughly with paint thinner or soap and water. This final rinse gets rid of any wax left by the remover and any acids that may have worked into the grain of the wood.

Fillers. Holes, dents, and cracks in surfaces and open-grained woods should be filled before finishing.

Putty, wood fillers, and even sawdust mixed with glue can be applied to wood. Deep cracks in wooden booms, spars, and the like should first be caulked with oakum or cotton caulking and then covered with putty.

Epoxy cements are available for use on steel and aluminum surfaces. Methods of application vary with the type of cement, so carefully follow instructions.

All fillers should be allowed to dry and then sanded smooth before you apply the first finishing coat.

Using Brushes and Rollers

Smooth and even painting depends as much on good brush-work as on good paint. There is a brush for almost every purpose, so pick the proper brush and keep it in the best condition.

With a flat brush, a skillful painter can paint almost any shipboard surface. Flat brushes are wide and thick, hold a lot of paint, and give maximum brushing action. Sash brushes are handy for painting small items, for cutting in at corners, and for less accessible spots. The fitch brush also is useful for small surfaces. The painter's dusting brush cleans surfaces.

Handling a Brush. Grip paintbrushes firmly but lightly. Do not put your fingers on the bristles below the metal band. This grip permits easy wrist and arm motion; to hold the brush otherwise restricts your movement and causes fatigue.

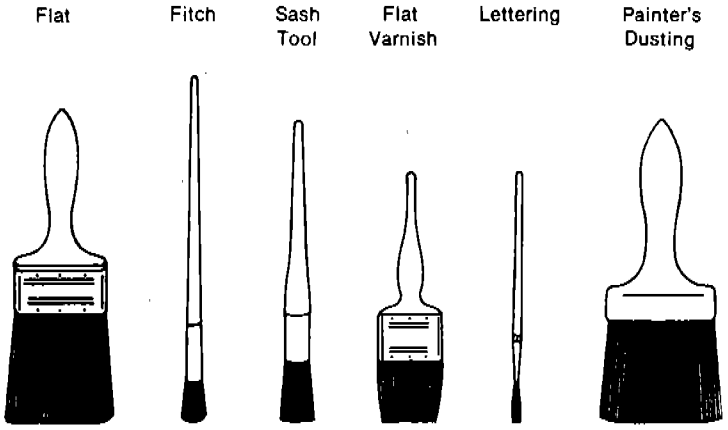


Figure 16.3. Types of paint brushes used in the Navy.

When using a flat brush, don't paint with the narrow edge. This practice wears down the corners and spoils the shape and efficiency of the brush. When using an oval brush, don't let it turn in your hands. An oval brush, if revolved too much, soon wears to a pointed shape and becomes useless. Don't poke oversized brushes into corners and around moldings; this bends the bristles, eventually ruining a good brush. Use a smaller brush that fits into such odd spots.

Dip the brush into the paint halfway up the bristles. Remove excess paint by patting the brush on the inside of the pot. (If you oversoak the brush, paint will drip and run down the handle.) Hold the brush at right angles to the surface with the bristles just touching it. Lift the brush clear of the surface when starting the return stroke. If the brush is held obliquely and not lifted, the painted surface will have overlaps, spots, and a daubed appearance. A brush held at any angle other than a right angle will soon wear away at the sides.

For complete and even coverage, follow the Navy method and first lay on, then lay off. Laying on means applying the paint first in long strokes in one direction. Laying off means crossing your first strokes. This way the paint is distributed evenly over the surface, the surface is covered completely, and a minimum amount of paint is used.

Always paint overhead first, working from the corner that is farthest from compartment access. By painting the overhead first, you can wipe drippings off the bulkhead without smearing its paint. Coats on overhead panels should normally be applied in a fore-and-aft direction, those on the beams athwartships. But where panels contain many pipes running parallel with the beams, it is often difficult to lay off the panels fore and aft. In this case, lay off the panels parallel with the beams.

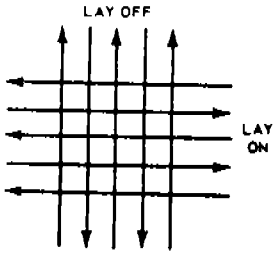


Figure 16.4. The Navy method of painting, known as "laying on and laying off."

To avoid brush marks when finishing up a square, use strokes directed toward the last square finished, gradually lifting the brush near the end of the stroke while the brush is still in motion. Every time the brush touches the painted surface at the start of a stroke, it leaves a mark. For this reason, never finish a square by brushing toward the unpainted area; instead, brush back toward the area already painted.

When painting pipes, stanchions, narrow straps, beams, and angles, lay the paint on diagonally. Lay off along the long dimension.

Always carry a rag to wipe up dripped or smeared paint. Carefully remove loose bristles sticking to the painted surface.

Paint on interior surfaces must be applied in the lightest possible coat, only enough to cover the area. Heavy layers of paint are a fire hazard—the thicker they are, the faster they will burn; they are likely to entrap solvents and thinners that burn rapidly; they have a greater tendency to crack and peel; they are uneven, and may show marks and scratches more readily than thinner coats; and they do not penetrate as well as thinner coats or dry as well. Moreover, heavy layers of paint, which add noticeably to the weight of the ship, may cut her speed.

Paint Rollers. The dip paint roller used in the Navy is equipped with a replaceable cylinder of knitted plush over a solvent-resistant paper core. It rotates on the shaft of a corrosion-resistant steel frame.

Large areas, such as decks and ship's sides (free of rivets, bolts, cables, pipes, and so on), can be covered with paint quickly by the roller method. Paint should be laid on and laid off the same way as with brushes. A moderate amount of pressure must be applied to the roller so that the paint is worked into the surface. If pressure is not exerted, the paint will not adhere and soon it will peel off. With the proper amount of pressure, a roller applies a more even coat and uses less paint than a brush.

Care of Painting Supplies and Equipment

Unfortunately, far too many good brushes and rollers are ruined simply because painters have little or no idea how to care for them. A perfectly good can of paint can be ruined after using only a little if the painter is careless. When painting, treat the paint, brushes, and rollers as though you paid for them yourself.

Do not let a brush stand on its bristles in a pot of paint for more than a few minutes. The weight of the brush bends the bristles, making it almost impossible to do a good paint job.

Never allow paint to dry on a brush. If you intend to leave a paint-filled brush for an hour or more, fold wax paper or some other heavy paper around the bristles to keep air out. Twist the paper around the handle and secure it with rope yarn or sail twine. Cover your pot of paint, and place both it and the brush in a safe place. Before resuming your job, stir the paint thoroughly with a paddle—not with the brush.

At the end of the day, before turning in your paint and brush to the paint locker, clean as much paint from the brush as possible by wiping it across the edge of the paint pot or mixing paddle. Ordinarily, those working in the paint locker will clean and stow any brushes turned in. They may require your help, and you may be detailed to the job. If so, follow instructions carefully, and thoroughly clean the brushes.

Paint lockers usually have containers with divided compartments for temporarily stowing brushes that have been used for different purposes (such as paint, varnish, or shellac). Most of these containers have tight covers and suspend brushes so that the bristles and the lower part of the ferrule are covered by thinner or linseed oil. Brushes to be used the following day should be cleaned in the proper thinner and placed in the proper compartment of the container. Those not to be used again soon should be cleaned in thinner, washed in soap or detergent and water, rinsed thoroughly in fresh water, and hung to dry. After drying, they should be wrapped in waxed paper and stowed flat. Do not leave a brush soaking in water. Water causes the bristles to separate into bunches, flare, and become bushy.

Paint rollers are cleaned differently. The fabric cylinder should be stripped from the core, cleaned in the solvent recommended for a particular type of paint, washed in soap and water, rinsed thoroughly in fresh water, and replaced on the core to dry. Combing the fabric's pile while it is damp prevents matting.

Conservation

Every job in the Navy, whether it has to do with maintenance, cleanliness, or almost anything else, requires conservation. Conservation doesn't mean that you should set aside extra stores like a packrat because you think you might need them sometime. Nor does it mean that you should try to save a bit by using one coat of paint when two are required. It *does* mean that you should make effective use of material and time to do the most work at the least possible cost. Although in many ways it is very different from your typical civilian corporation, the Navy is a business, and everything used—whether it

is consumable supplies or your time—must be paid for. Just because all you do is sign a chit to draw something from supply doesn't mean it's free. Someone has to pay for it. And keep in mind that you, as an American taxpayer, help pay.

Inspections

Conducted to ensure the readiness of personnel and equipment and to maintain the high standards required of an impressive, combat-ready organization, inspections are a periodic part of shipboard life. Because inspections are similar in many ways to tests we have all encountered in school, it is only human nature to become somewhat apprehensive before an impending inspection. But, besides their obvious necessity, inspections are a time for you to show what you can do, to demonstrate what you have learned, and to prove that you are the kind of person that will meet the unique challenges that life in the U.S. Navy sometimes brings. Whether it is a personnel inspection, a zone inspection, or some other type, it is an opportunity to you to excel. If you are properly prepared, it will be an enjoyable experience and will contribute to overall unit readiness. If you are not adequately prepared, an inspection can be a very uncomfortable experience.

If you are in charge of a compartment that is being inspected, present the space to the inspecting officer by saluting and greeting her or him in the following manner: "Good afternoon [morning], ma'am [sir]; Seaman Jones, compartment [name and number], ____ Division, standing by for inspection."

Watchstanding

Unlike many civilian businesses, ships cannot shut down for the night. Someone has to keep the engineering plant running whether it is night or day. When the ship is underway, someone must be constantly navigating and someone else must steer. Even in port, many functions must be performed aboard ship around the clock. Because of this, and because the same people obviously cannot carry out these functions without rest, Sailors serving in ships must often stand watches. Watchstanding, in its simplest form, could be described as an organized means of "taking turns." Watch organization is covered in chapter 4 of OPNAVINST 3120.32.

Conditions of Readiness

The watch organization is determined by the ship's condition of readiness. These are described below, and it should be apparent that,

generally speaking, the lower the number of the readiness condition, the more people will be required to be on watch. Material conditions of readiness (discussed in chapter 18) are set accordingly as well.

Condition I. Known as "general quarters." All hands are at battle stations and the ship is in its maximum state of readiness. This condition is set on board ship if the ship is expecting combat or if some other emergency situation (such as a bad fire) occurs. Everyone on board has an assigned station that he or she must go to whenever Condition I is set.

Condition II. This condition is set only on large ships and is used when the ship is expecting to be in a heightened state of readiness for an extended period of time but the operations at hand are such that some relaxation of readiness is permissible.

Condition III. Wartime cruising with approximately one-third of the crew on watch. Weapon stations are manned in accordance with the threat and other stations are manned or partially manned to fit the particular circumstances.

Condition IV. Normal peacetime cruising. Only necessary persons on watch, while the rest of the crew engages in work, training, or recreation as appropriate. This condition ensures an adequate number of qualified personnel are on watch for the safe and effective operation of the ship, yet allows for the most economical use of personnel in watch assignments.

Condition V. Peacetime watch in port. Enough of the crew is on board to get the ship under way if necessary or to handle emergencies.

Condition VI. Peacetime watch in port where only minimum personnel are required to keep an eye on the ship in order to maintain minimum security and to watch for fire or flooding. The ship will not be able to get underway without bringing more personnel on board and will require outside assistance to fight anything more than a minor fire.

There are also several variations of Condition I designed to meet special circumstances.

Condition IA. All hands on station to conduct amphibious operations and a limited defense of the ship during landing operations.

Condition IAA. All hands on station to counter an air threat.

Condition IAS. All hands on station to counter a submarine threat.

Condition IE. Temporary relaxation from full readiness of condition I for brief periods of rest and distribution of food at battle stations. This condition is set for brief periods during a lull in operations.

Condition IM. All hands on station to take mine countermeasures.

Watch Organization

Literally hundreds of different kinds of watches are stood throughout the Navy. They differ in length and the type of duties performed depending upon circumstances. But there is a model that is either used in actuality or is departed from as necessary. This model is based upon normal shipboard conditions and has been traditional for centuries. It is based upon four-hour watches that run around the clock. Four hours is the standard because that is widely accepted as the optimum time for a person to carry out the duties associated with operating a ship without suffering the dangerous effects of fatigue.

Table 16.2 shows the four-hour model, running from midnight to midnight.

Ship's Bells

For many centuries, Sailors did not have the luxury of a personal timepiece. If watches were to be relieved on time, some means of telling the time had to be devised. A system that used a half-hour sand-glass and the ship's bell was created and used for hundreds of years.

At the beginning of a watch, the sand-glass was turned over to start it running. As soon as it ran out, the watchstanders knew the first half-hour had passed, so they rang the ship's bell once and immediately turned the sand-glass over to start the second half-hour. Everyone on board the ship could hear the bell being rung so they could keep track of the time. When the sand ran out the second time, the watchstanders rang the ship's bell twice. They continued this until eight bells had been rung (representing the passage of four hours or one complete watch). The watch was then relieved, and the new

Table 16.2. Watch Organization

Period	*Known as*
0000–0400	Midwatch
0400–0800	Morning watch
0800–1200	Forenoon watch
1200–1600	Afternoon watch
1600–1800	First dog watch[a]
1800–2000	Second dog watch[a]
2000–2400 (0000)	Evening watch[b]

[a]The first and second dog watches straddle the time when the evening meal is traditionally served. Those with the first dog eat the evening meal after being relieved and those with the second dog eat before assuming the watch.
[b]Also called the "first watch."

watch team started the whole cycle over by ringing one bell once the first half-hour had passed, and so on. This bell-ringing tradition has been continued on board many Navy ships even though clocks and watches are now very common. Today, because bells are rung more out of tradition than for real function, they are not normally rung between taps and reveille (normal sleeping hours for Sailors not on watch), nor are they rung during divine services or in fog, when the ship's bell is used as a fog signal. Another tradition, still observed in many Navy ships, is the custom of the youngest member of the crew striking eight bells at midnight on New Year's Eve to ring in the new year.

Table 16.3 shows the cycle of daily bell-ringing and what the various bells mean in terms of time and watches.

Watch Sections

On board ship, you will more than likely be assigned to a watch section. When the word is passed that a specific section has the watch, everyone in that section immediately reports to his or her watch station. Different ships will have different numbers of watch sections, depending upon the size of the ship and upon the condition of readiness in effect.

Relieving the Watch

When relieving the watch, you should always report at least 15 minutes before your watch is scheduled to begin so you can receive information and instructions from the off-going watch. Most ships muster oncoming watch sections to make sure each watchstander is ready ahead of time, but even if there is not a formal muster, you should always arrive early (at least fifteen minutes—longer if there is a lot going on). This is to allow you enough time to be sure that you fully

Table 16.3. Cycle of Daily Bell-Ringing

Bells	*Mid*	*Morning*	*Forenoon*	*Afternoon*	*Dogs*	*Evening*
1 bell	0030	0430	0830	1230	1630	2030
2 bells	0100	0500	0900	1300	1700	2100
3 bells	0130	0530	0930	1330	1730	2130
4 bells	0200	0600	1000	1400	1800	2200
5 bells	0230	0630	1030	1430	1830	2230
6 bells	0300	0700	1100	1500	1900	2300
7 bells	0330	0730	1130	1530	1930	2330
8 bells	0400	0800	1200	1600	2000	2400 (0000)

understand all that is going on and all that is expected of you before you assume responsibility for the watch. Relieving the watch is a controlled and precise function and should always be treated as very serious business. Formality is the rule and casual behavior is clearly out of place.

The following steps are the minimum requirements for a good watch turnover:

1. State to the person you are relieving, "I am ready to relieve you." (Use these exact words so there is no possibility of confusion. "What'cha got?" or "I'm ready" is not sufficient).

2. Once the off-going watch has explained everything that is going on or is likely to happen and you have asked all the questions you need to ask, you and the person you are relieving should report your readiness to assume the watch to the next senior person in the watch organization by saying, "Request permission to relieve the watch."

3. The senior watchstander will respond by saying, "Permission granted."

4. The offgoing watch will render a salute to the senior watchstander and state, "[Watchstation] properly relieved by [your rate and name]."

5. You should then signify to all present that you have formally accepted the duties of the watch by saluting the senior watchstander and stating, "I assume the duties of [watchstation]."

This procedure unequivocally transfers the responsibility for the watch from the previous watchstander to you. Thereafter, you assume complete authority and responsibility for the watch until someone follows the same procedure to relieve you of the watch.

Watch Stations

As already stated, there are hundreds of different watches in the Navy—too many to be discussed here—but several of the key shipboard stations are worth mentioning.

Bridge Watches

While a ship is underway, the bridge watch team ensures the safe navigation of the ship, supervises the daily routine, monitors communications, conducts drills, and generally oversees the safety and smooth operation of the ship. The OOD is in charge of this team and is the captain's direct representative for these duties.

Before an individual can stand OOD watches, the nature of the responsibilities involved requires that he or she must earn the trust of

the captain. This is accomplished through an intensive training program that includes adequate testing. Because no two ships are exactly alike—either in their physical layout or in their procedures—qualification as OOD on one ship does not automatically qualify the individual to stand OOD watches on other ships. OODs must requalify each time they join another ship.

Depending upon the ship, the OOD may be assisted by a junior officer of the deck (JOOD) and, on larger ships, there may be a junior officer of the watch (JOOW) as well.

Other members of a typical bridge watch team are:

Boatswain's mate of the watch (BMOW). The BMOW supervises and trains the enlisted members of the watch team, passes the word over the ship's general announcing (1MC) system, and assists the OOD and JOOD as directed. It is his or her responsibility that all deck watch stations are manned and that all hands in previous watch sections are relieved. Although it is the duty of the section leader and the division petty officer to instruct the people they send on watch, the BMOW must verify that every person on watch has been properly instructed and trained. A BMOW must also be a qualified helmsman.

Quartermaster of the watch (QMOW). Assigned from the navigation department, the QMOW maintains the ship's log and assists the OOD in navigational matters, including changes of weather and the movement of shipping. This watchstander is also a qualified helmsman.

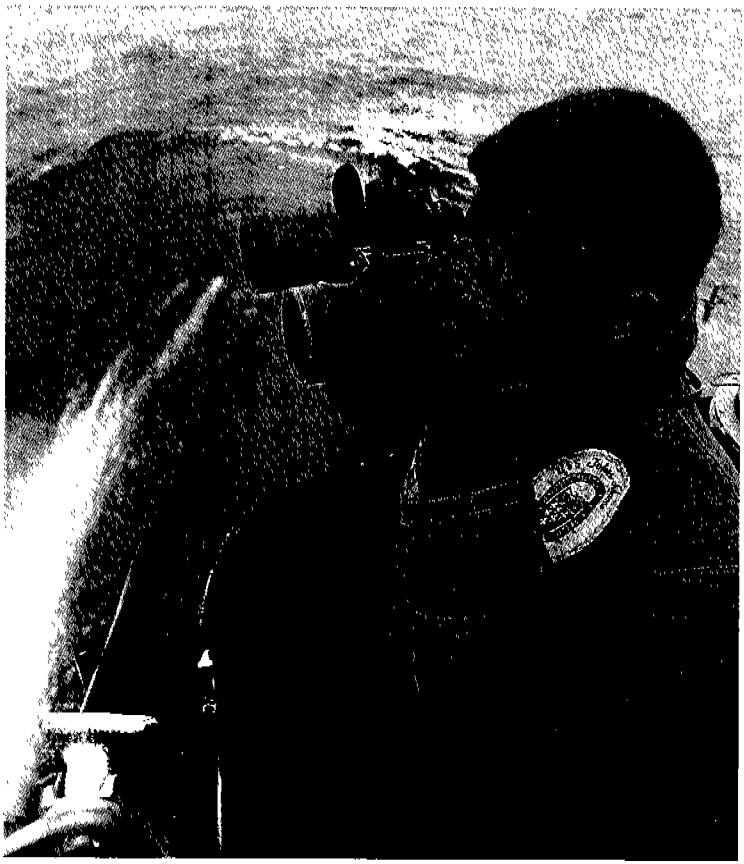
Helmsman. Steers the ship as directed by the conning officer.

Lee-helmsman. Controls the engines as directed by the conning officer.

Lookouts. These watchstanders function as extra pairs of eyes for the OOD, scanning the sea and sky and reporting all significant objects and events. Navy regulations require that night lookouts report on the ship's navigational lights every half hour to make sure they are burning. By tradition, the starboard lookout reports, "Starboard side light, masthead light, bright lights, sir"; the port lookout reports, "Portside light, range light, bright lights, sir." (See chapter 21 for more information regarding lookout watches.)

Phone-talkers. These individuals man those sound-powered telephone circuits as necessary to maintain communication with other key watch stations (such as the lookouts and engineering watchstanders).

Messenger. This watchstander delivers messages, answers telephones, wakes up watch reliefs, and carries out other duties assigned by the OOD.



PH3 Philip J. Fraga

Figure 16.5. Standing lookout watches is one of the duties you may be required to perform aboard ship.

Quarterdeck Watches

In port the OOD shifts the watch from the bridge to the quarterdeck. Although the ship is not underway, the OOD must still be vigilant about the safety of the ship, checking mooring lines or anchor chains as appropriate, monitoring weather conditions for any significant changes, and controlling access to the ship. The OOD and her or his watch team supervise and carry out the ship's routine, conduct honors and ceremonies as appropriate, control the ship's 1MC system, conduct drills, and carry out any additional orders from the captain, the executive officer, or the command duty officer (an officer placed in charge of the ship in the captain's absence).

Just as at sea, the OOD is assisted by a watch team in port. The OOD's principal assistant is the petty officer of the watch (sometimes called the BMOW just as when underway). There will nearly always be one or more messengers of the watch assigned and, depending upon circumstances, there may be a JOOD, JOOW, and/or a QMOW assigned as well. If the ship is at anchor, lookouts may be required, and an anchor watch will normally be added to keep an eye on the anchor chain and report any strain or other problems to the OOD.

Engineering Watches

The engineering watch team is headed by the engineering officer of the watch (EOOW). He or she is responsible for the safe and proper performance of all engineering watches and ensures that all orders from the OOD are promptly and properly executed. The EOOW is assisted by a number of watchstanders that vary depending upon the type of engineering plant.

Damage-Control Watches

The damage-control watch team is responsible for maintaining the proper material condition of readiness and for checking, repairing, and keeping in full operation the various hull systems affecting watertight integrity, stability, and other conditions that affect the safety of the ship.

Combat Information Center (CIC) Watches

The number and types of watches in CIC will vary considerably according to the condition of readiness and the types of operations being conducted. Under routine underway operations, there will be a CIC watch officer (CICWO) who will be assisted by one or more radar and radio operators. This team detects, reports, tracks, and evaluates air, surface, and submarine contacts during the watch.

When conditions warrant (combat potential is increased) a tactical action officer (TAO) may be assigned by the commanding officer to take timely and decisive action in matters concerning the tactical employment and defense of the unit. The TAO is responsible for the safe and proper operation of combat systems.

Departmental Duty Watches

Because members of the crew go ashore in port, it is important to have qualified personnel assigned to carry out normal or emergency departmental functions. Each department will assign a duty department head and additional personnel as necessary to be responsible for depart-

mental functions. The supply department, for example, may assign a duty supply officer, a duty storekeeper, or duty cooks as necessary.

Logs. A log is a permanent, written record that can have legal status in a court of law. For these reasons, log entries should be complete, accurate, and in standard naval language. Names should be printed, and figures must be recorded carefully. The ship's deck log, engineering log, compass record, and engineer's bell book are the official records of a ship. Because of their legal status, no erasures may be made in any of these logs. When a correction is necessary, a line can be drawn through the original entry so it remains legible and the correct entry inserted. Corrections, additions, or changes in any log are made only by the person required to sign it, and initialed by that person in the margin of the page.

Ship's deck log. This is the official chronological record of events occurring during a bridge or quarterdeck watch, which may concern the crew, operation, and safety of the ship, or may be of historical value. The OOD supervises the keeping of the log, and the QMOW (or other designated watchstander) actually writes the log. Each event is recorded in accordance with standing instructions. All log entries are made with a ballpoint pen, using black ink. Sample deck-log entries are contained in the *Watch Officer's Guide.*

The navigator examines the log daily, and the commanding officer approves it at the end of each month. The original ship's deck log goes to the chief of naval operations every month. A duplicate copy is kept on board for six months, after which it may be destroyed.

Compass record book. This is a complete record of the reading of all compasses on board. It also records gyrocompass errors. When the ship is under way, comparisons between compasses are made on every course change and entered in the book.

Engineering log. This log is the official record of important information about the operation of the propulsion plant and auxiliary equipment. It contains entries such as the total miles steamed for the day, the ship's draft and displacement, engineering casualties experienced, and other pertinent information as described in OPNAVINST 3120.32.

Engineer's bell book. This is a chronological record of all orders issued by the bridge that pertain to the propulsion plant.

Shipboard Training

One aspect of shipboard life that you can count on is *training.* Some of it will be traditional, involving lectures and books, but a lot of your

shipboard education will take the form of on-the-job training. Drills, in which you will simulate an actual situation and use the equipment involved as much as possible, are another means of training frequently employed on board naval vessels.

On-the-Job Training

Frequently referred to as "OJT," this is probably the most frequently employed method of training on board a Navy ship. It is usually the least formal method of training and relies upon the experience of those who have been doing a particular task for a while to pass on their acquired expertise to those just learning the ropes. On a well-run ship, where pride in performance is evident, OJT will take place—without having been directed or scheduled—nearly every time two or more individuals stand a watch or conduct some routine maintenance together. Rather than an experienced individual merely doing a task, she or he will explain to another less-experienced individual what she or he is doing as they do it. Or he or she will let the less-experienced individual actually do the task while the experienced person supervises and assists. For example, you may be standing a bridge watch as messenger with an experienced petty officer who is the quartermaster of the watch (QMOW). Sunrise has just occurred, and it is time to turn off the ship's navigational lights. Rather than merely turn off the lights herself, the QMOW shows you where the light panel is, identifies each of the switches for you, explains what the various positions of the switches do, and then lets you actually turn off the lights—checking the secondary filaments as you do so—while she observes.

This kind of training is to everyone's advantage. The experienced person receives some assistance and has an opportunity to reinforce his or her own knowledge through teaching others, and you, as the inexperienced person, get an opportunity to improve yourself, increasing your chances for advancement, making you more useful to the organization and your shipmates, and giving you a source of pride in accomplishment. An added advantage of this type of training is that the more people there are who are capable of carrying out a task, the less chance of a problem in an emergency or when someone is ill or wants to go on leave.

Drills

This type of training is extremely important, particularly when practicing for emergencies such as fire and man overboard. It is vital that

you know exactly where to go, where to find what you need, and be familiar with the equipment and procedures involved. It is also vital that you and everyone involved in complex evolutions are able to function as a team. You might think of drills as a form of advanced OJT which is more organized and usually involves more people.

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Safety and Emergencies

U.S. Navy ships are, for the most part, very safe places to live and work. More than 200 years of experience, a high state of training and readiness, and many technological developments have minimized the dangers that must necessarily exist in a vessel that ventures onto the sometimes unpredictable waters of the world carrying ammunition, fuel, and other potentially hazardous materials. But the safety enjoyed aboard an American naval vessel is only as effective as the safety practices of its individual crew members. You must not go around in constant fear while serving in a ship, but you must always be aware that there are dangers that must be protected against. Safety precautions are an essential element of shipboard life, and you owe it to yourself and to your shipmates to make safety precautions a part of your everyday routine.

This chapter will introduce you to some of the more important safety precautions that must be continually practiced in the Navy. Because safety precautions are sometimes ignored or forgotten, and because accidents occasionally happen despite all attempts to prevent them, this chapter will also discuss some of the emergencies you may face aboard ship.

Safety

As already stated, safety is a job for all hands at all times. Every single operation aboard a naval vessel poses danger. Going to sea involves working with powerful machinery, high-speed equipment, steam of intensely high temperature and pressure, volatile and exotic fuels and propellants, heavy lifts, high explosives, stepped-up electrical voltages, and the unpredictable forces of weather. It is the responsibility of everyone aboard ship to observe all safety precautions.

Safety precautions for each piece of equipment used in the Navy are available and should be read and understood. The *Naval Ships' Technical Manual* (more often referred to as the NAVSHIPSTECHMAN), the *Standard Organization and Regulations of the U.S. Navy,*

and numerous bureau and systems manuals contain written safety regulations.

Another important part of safety is the regular maintenance of equipment and systems. Maintenance involves much more than just cleaning and painting. For safety and efficiency, every item aboard ship—from the simplest valve to the most complicated electronic gear—must be clean and operable.

The following general instructions, listed alphabetically for easier reference, serve as an introduction to the most important principles regarding shipboard safety.

Aircraft Operations

During aircraft operations, only those personnel actually involved are allowed in the flight-deck area. All other personnel must remain clear or below decks. Personnel involved in flight operations must wear appropriate safety equipment (helmet, goggles, etc.).

Before aircraft operations can actually begin, the flight deck must be checked for loose materials that might cause damage if sucked into an aircraft engine. This procedure is called a "FOD" walkdown. FOD stands for foreign object damage, and the procedure involves personnel walking slowly along the flight deck, carefully watching for any loose debris or objects that might cause damage. A single small screw or a chip of paint can spell disaster for the turbines in an engine and must therefore be removed.

Passengers must be led to and from a helicopter or aircraft by a member of the transfer crew, handling crew, or flight crew. All loose gear in the flight-deck area is stowed elsewhere or secured to the deck. Personnel are taught about the shrapnel effect of rotor blades or propellers striking a solid object. Be careful around propellers and helicopter rotors. When turning, they are nearly invisible but are extremely dangerous. Rotor tips cover a wide area and often dip close to the deck when the helo lands. An aircraft making a turn while taxiing can put you in harm's way very quickly. The engine noise of the plane you are watching will drown out the noise of planes you are not watching. Don't move without looking in all directions, and don't direct all your attention to a single aircraft.

Also beware of jet blast. Any place within 100 feet of a jet engine is dangerous. A jet blast can burn, knock down, or blow a person over the side.

Ammunition Handling

Everyone who handles ammunition must be instructed in safety regulations, methods of handling, and the stowage and uses of ammunition

and explosives. Only careful, reliable, mentally sound, and physically fit Sailors are permitted to work with explosives or ammunition.

Anyone who knows of defective ammunition or other explosive ordnance, defective containers or handling devices, the rough or improper handling of ordnance, or the willful or accidental violation of safety regulations must report the facts to his or her immediate superior.

Anyone supervising the inspection, care, preparation, handling, use, or disposal of ammunition or explosives must see that all regulations and instructions are observed, remain vigilant throughout the operation, and warn subordinates of the need for care and vigilance. Supervisors must also ensure that subordinates are familiar with the characteristics of explosive materials, equipment used to handle them, safety precautions, and the catastrophes that safety regulations are designed to prevent.

Matches, lighters, and any other spark- or flame-producing devices are not permitted in the vicinity of ammunition except under specific circumstances when necessary and when approved by the commanding officer.

Crews working with explosives or ammunition are limited to the minimum number required to perform the operation properly. Unauthorized personnel are not permitted in magazines or in the immediate vicinity of loading operations. All authorized visitors must be escorted.

The productivity of persons or units handling explosive ordnance is never evaluated on a competitive basis that will lead to unsafe practices.

Live ammo, rockets, or missiles are loaded into guns or on launchers only for firing, except where approved by the Naval Sea Systems Command or as permitted below.

Nothing but inert (nonexplosive) ammo is used for drill purposes, except under certain special circumstances.

Supervisors must require good housekeeping in explosive spaces. Nothing is to be stored in magazines and other ammunition-handling spaces except explosives, their containers, and authorized handling equipment.

No warhead detonator should be assembled in or near a magazine containing explosives. Fuzing is performed only at a designated fuzing area.

Boats

In motor launches, only the coxswain and the boat officer or senior line officer may ride on the coxswain's flat. No boat may be loaded

beyond the capacities established by the commanding officer (published in the boat bill) without his or her specific permission, and then only in emergencies.

To provide adequate traction, all members of a boat's crew wear rubber-soled canvas shoes in the boat. Boat crews must demonstrate a practical knowledge of seamanship, rules of the road, and safety regulations. Qualification for serving as a member of a boat crew is granted by the ship's first lieutenant. The engineering officer is responsible for all boat engines and their electrical systems, and will ensure that qualified personnel are available to operate and maintain them. Only personnel designated by the engineering officer will fuel the ship's boats, operate boat engines, or work with any component of the boat's electrical system, including the battery.

No one should ever board a boat from a boat boom unless someone is standing by on deck or in a boat at the same boom (to render assistance in case of a fall or some other difficulty).

All boats leaving the ship must have local charts with courses to and from their destinations plotted on them. They must have an adjusted and lighted compass installed and enough life preservers to accommodate each person embarked. These should be readily available when rough seas, reduced visibility, or other hazards threaten.

Chemicals

Adequate precautions should be taken when stowing, handling, and disposing of hazardous chemicals and materials. All chemicals, particularly unfamiliar ones, should be treated with respect. Unless you know otherwise for certain, always assume a chemical substance is hazardous and treat it accordingly.

A review of all potential hazards is not possible here, but substantial chemical-safety information is available in a number of references. Material Safety Data Sheets (MSDS) are provided by the manufacturers of hazardous materials (HAZMAT) stored on board ship. MSDS sheets include information on immediate actions to be taken in case of emergencies (such as when chemicals are spilled or when personnel come into unprotected contact with these dangerous materials).

The *Naval Ships' Technical Manual* (NAVSHIPSTECHMAN) has requirements and safety guidelines on a wide variety of hazardous chemicals, including cleaning agents, solvents, paints and associated chemicals, chlorinated hydrocarbons, mercury, oxidizing materials, corrosive liquids, and materials in aerosol containers.

Safety Precautions for Shore Activities (OPNAV Instruction 5100.23) includes information on the hazards of and precautions to

be taken in using laboratory, photographic, and painting chemicals, as well as alkalies, acids, solvents, cleaning agents, cyanides, organic phosphates, toxic metals/dusts, and halogenated hydrocarbons.

Hazardous Material Information System (DOD Instruction 6050.5) lists hazardous items in federal stock, classifies material according to the type of hazard, and recommends proper stowage.

Afloat Supply Procedures (NAVSUP P-485) contains information on the receipt, custody, and proper stowage of hazardous materials.

Navy Hazardous Material Control Program (NAVSUP Instruction 5100.27) provides guidelines for procedures to follow when seeking information on the nature, hazards, and precautions of unknown chemicals and materials.

Electrical and Electronic Equipment

Electrical equipment includes generators, electrically powered machinery and mechanisms, power cables, controllers, transformers, and associated equipment. Electronic equipment includes radars, sonars, power amplifiers, antennas, electronic-warfare equipment, computers, and associated controls. The most important precautions with all such equipment are to treat them with respect and never work on them alone.

As a basic rule, no one is to operate, repair, or adjust any electrical or electronic equipment unless he or she has been assigned that duty, except in definite emergencies. However, common sense must prevail here: electric lights and bulkhead-mounted electric-fan switches are exempted, for example. If you have *any* doubt about whether or not you should be operating a piece of electrical or electronic equipment, *don't*. A Navy training film about electrical safety, *The Deadly Shipmate,* has been around for many years. That is an apt description of electricity. It is truly a shipmate that can be relied upon to provide comfort, convenience, and combat readiness, but it is unquestionably *deadly* when improperly used.

You should never remove, paint over, destroy, or mutilate any name plates, cable tags, or other identification marks on electrical or electronic equipment. Never hang anything on, or secure a line to, any power cable, antenna, wave guide, or other piece of electrical or electronic equipment.

Only authorized portable electric equipment that has been tested and certified by the electric shop may be used.

Electric equipment should always be de-energized and checked with a voltage tester or voltmeter before being serviced or repaired. Circuit breakers and the switches of de-energized circuits must be

locked or placed in the off position while work is in progress, and a suitable warning tag should be attached to them.

Work on live circuits or equipment is carried out only when specific permission has been received from the commanding officer. The person performing the work must be insulated from the ground and must follow all safety measures. Rubber gloves are worn and another person stands by to cut the circuit and render first aid if necessary. Medical personnel are alerted before such work begins.

Personal electronic equipment (such as tape players or radios) must be inspected by the electrical or electronic workshop to ensure that it conforms to NAVSHIPSTECHMAN regulations.

Only authorized light fixtures with protective screens or shields are installed in machinery spaces.

Going aloft (onto upper areas of the superstructure or onto the ship's masts where there are radio, radar, or electronic warfare antennas mounted) can be very dangerous for a number of reasons. Electrical shock is an obvious hazard, but you can also be seriously injured by electronic emissions or struck by a rotating antenna. The emissions from such equipment can also charge the ship's rigging with enough electricity to do you serious harm. You should never go aloft unless adequate safety precautions have been employed, which will normally include securing all potentially hazardous equipment in the vicinity and making certain that equipment tag-out procedures are in effect to prevent the accidental energizing of secured equipment. These procedures are formalized and controlled by what is called a "man-aloft chit." This check list requires all pertinent departments to be notified that someone is going aloft, so that they can take the appropriate safety precautions (turn off their antennas, etc.). As a precaution, duty department heads must sign the chit, acknowledging that a person is going aloft.

Because you do not have to be in actual contact with many of these equipments for them to do you serious harm—just being in the vicinity of a transmitting radar can do serious internal organ damage, for example—it is important to remember that an adjacent ship (one moored next to you in port) can also be hazardous to you if you go aloft on your ship. In these situations, all necessary precautions must be taken on *both* ships before anyone may go aloft on either.

Electrical and electronic safety precautions must be conspicuously posted. Personnel are to be instructed and drilled in their observance and anyone who routinely works on electrical and electronic equipment must be qualified to administer first aid for shock. He or she should also be capable of performing emergency resuscitation proce-

dures and able to use airway breathing tubes. Instructions for these procedures are posted in spaces containing electronic equipment.

Rubber matting (except where vinyl sheet is specified) is installed in areas where the potential for electrical shock exists.

Fire and Explosion Prevention

Reducing fire and explosion hazards is every Sailor's responsibility. Whenever possible, hazards should be eliminated, including nonessential combustibles (things that will burn). Replace combustible materials with less flammable ones if you can. Limit the number of combustibles whenever possible. Those combustibles that are essential should be properly stowed and protected to reduce the chances of fire.

Whenever possible, you should prevent the accumulation of oil and other flammables in bilges and inaccessible areas. Stow oily rags in airtight metal containers and paint, brushes, rags, thinners, and solvents in authorized locations only. Do not use compressed air to accelerate the flow of liquid from containers of any type.

Forklifts

Only authorized persons should operate forklifts. Before operating one, check its condition. Keep feet and hands inside the running line. No one other than the operator should ride a forklift, unless it has a second permanent seat.

On wet or slippery decks and when turning corners, always slow the forklift down. Never stand under loads being hoisted or lowered, and never permit anyone else to do so.

All cargo should be transported with the load-lifting rails tipped back. When you are moving, keep forks four to six inches above the deck, whether loaded or not. Do not exceed the specified load capacity. Lower and rest forks on deck when they are not in use.

Never bump or push stacks of cargo to straighten them. Forks should be worked all the way under their loads. Inspect each load before lifting. An unstable load should be rearranged or banded before being lifted.

Always come to a full stop before reversing the direction of travel. Put on the parking brake when you complete your work, park the forklift in a fore and aft position near the centerline of the ship, if possible, and secure it with chains or cables.

Hand Tools

You probably have worked with various tools before joining the Navy. Hammers, pliers, and screwdrivers are all common tools that

most people use on occasion. If you have used these tools, you have learned that certain precautions must be taken in order to keep from injuring yourself. In most cases, injuries from these tools are usually minor—a bruised thumb or a pinched finger. But serious injury can occur when a hand tool is not used in a safe manner and when certain precautions are not taken. Striking tools—hammers and chisels, for example—are particularly dangerous because they are used with sufficient force to cause serious injury if care is not exercised. Because of the importance and vulnerability of your eyes, safety goggles should be worn anytime you use a striking tool. Also be sure that anyone else in the vicinity is wearing safety goggles as well, or have them leave the area before you begin your work. Flying chips can travel a good distance and do serious harm if everyone in the area is not protected.

Select the right hammer for the job. The head should be wedged securely and squarely on the handle, and neither the head nor handle should be chipped, cracked, or broken. Keep the hammer clean and free of oil or grease; otherwise it might slip from your hands, or the face of the hammer might glance off the object being struck. Grasp the handle firmly near the end, and keep your eye on the part to be struck. Strike so the hammer face hits the object squarely.

Cold chisels should be held between the thumb and the other four fingers. On horizontal cuts, the palm should be up. Don't use a burred chisel, one with a mushroomed head, or one that is not properly tempered or sharpened.

Wood chisels should be free of cracks. Don't use one with a mushroomed head. Cup the chisel handle in the palm of your hand and exert pressure away from the body. Be sure no one is close enough to be hurt if the chisel slips.

Hydraulic Machinery

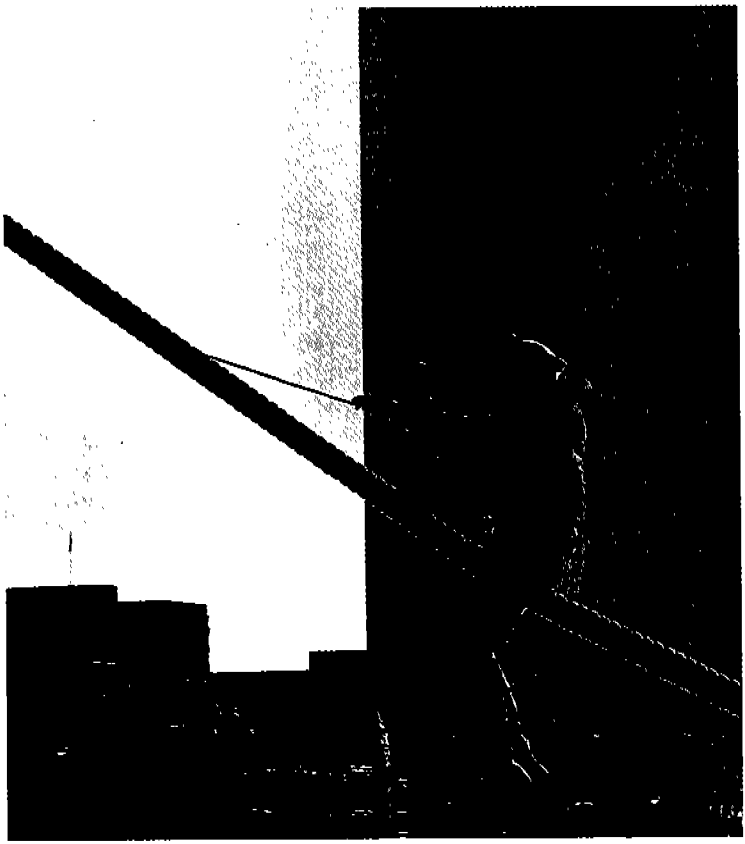
Hydraulically operated equipment can be extremely powerful. The lift in your hometown garage, which suspends entire automobiles six or more feet off the ground, is an example of a hydraulic system. Such equipment must never be used until all personnel are clear of moving parts. Imagine what would happen to you if you were under that garage lift when the mechanic decided to bring it down. While this is not a pleasant picture, it should serve to warn and remind you of the danger associated with hydraulic machinery. Such things as periscopes, rudders, diving planes, gun mounts, and missile launchers are all moved using hydraulic machinery that makes that garage lift seem puny by comparison. Always treat hydraulic systems with

respect and stand well clear when they are operating. Hydraulic machinery should always be secured and all equipment thoroughly checked when a hydraulic leak is detected or suspected.

Life-Jackets

Life-jackets can be a Sailor's best friend at certain times. Anytime you go topside in heavy weather you must wear a life-jacket. Being washed overboard is a very real danger when seas get rough, and being washed overboard without a life-jacket greatly reduces your chances of ever seeing your ship, home, or family again.

Life-jackets are also worn at times when the nature of your work increases the chances of your falling or being knocked overboard. Working on replenishment stations where booms or swinging cargo



U.S. Naval Institute

Figure 17.1. Sailors working over the side of the ship wear life jackets and safety harnesses.

may push you over the side is one example of a time you will need to put on a life-jacket. Life-jackets are also worn when working over the side in port and at sea, whether you are suspended over the side on a stage or in a "boatswain's chair," or using a small boat. You may be required to wear a life-jacket when traveling in a boat if weather or sea conditions warrant.

Lifelines and Safety Nets

The lifelines (railings) on a ship are there to prevent people from falling overboard. You should never lean, sit, stand, or climb on any lifeline whether the ship is underway or in port. People working over the side in port may climb over lifelines when necessary, but only if they are wearing life-jackets and safety lines that are tended.

No lifeline should be dismantled or removed without specific permission from the first lieutenant, and then only if temporary lifelines are promptly rigged.

No weights should be hung or secured to any lifeline unless authorized by the commanding officer.

Safety nets are also rigged around flight decks to catch anyone who may be blown over the side by an aircraft's propeller wash or jet blast. You should never enter a flight-deck safety net except as authorized.

Line Handling

Lines are used for many purposes aboard ships. True Sailors know that while lines are very useful, they can also be very dangerous. A mooring line (one that is used to secure a ship to a pier) that parts under strain is quite capable of instantaneously severing limbs. Always treat lines with respect. Do not, under any circumstances, stand in the bight (loop) of a line. If that line suddenly goes taut it can seriously injure you or drag you into danger. Never step on a line that is taut. Only a fool tries to check a line that is running out rapidly by stepping on it.

Synthetic lines (such as nylon) are widely used for mooring and rigging because of their durability and strength. These lines are characterized by high elasticity and low friction so extra turns will be required when the line is secured to bitts, cleats, capstans, and other holding devices. Nylon line stretches one and a half times its original length and then snaps back with tremendous force if the line parts. Do not stand in its direct line of pull when heavy loads are applied.

Materials Handling

You will probably—more than once—find yourself part of a working party that is bringing stores aboard or moving materials from one part of the ship to another. While you will not be able to avoid the hard work involved, you can avoid injury by taking some basic precautions. Safety shoes (with toe protection) must be worn when handling heavy stores or equipment. Always wear gloves when carrying, lifting, or moving objects that have sharp edges or projecting points. Always remove rings when wearing gloves.

Material should not be thrown from platforms or trucks to the floor or ground; use suitable lowering equipment if available.

Don't overload hand trucks. When working on a ramp or incline, keep the load below you—pull it up and push it down.

To lift a load, stand close to it with your feet solidly placed and slightly apart. Bend your knees, grasp the object firmly, and lift by straightening your legs, keeping your back as straight as possible.

Personal Protective Equipment

You only have one body. And while you may have two eyes, ten fingers, and two hands, you really cannot spare any of them. Protective clothing and equipment (such as hard hats, gloves, ear plugs and muffs, respirators, glasses and goggles, coveralls, and steel-toed shoes) were designed to help you keep your body intact and to ensure that all of your body parts continue to operate at peak efficiency. *Use them!*

Suitable gloves must be worn when working on steam valves or other hot units.

Keep the body well covered to reduce the danger of burns when working near steam equipment.

Welding goggles and a protective welding jacket must be worn when brazing, welding, or cutting. Personnel assigned as fire watches during welding operations must also wear protective goggles.

Protective goggles should also be worn whenever working with corrosive substances such as acid, alkali, and vinyl paint. Water in plastic squeeze bottles or other containers should be readily available.

Plastic face shields must be worn when handling primary coolant under pressure, and suitable eye protection—a shield, goggles, or safety glasses—must be used when buffing, grinding, or performing other tasks potentially hazardous to the eyes.

Do not wear clothing with loose ends or loops when working on or near rotating machinery.

Paint-Removing Tools

Paint-removing tools, whether they are simple hand tools such as a chipping hammer, or electrical and pneumatic tools, such as chippers, grinders, and scalers, are useful but potentially hazardous tools if not used with care. Because flying paint chips are an obvious hazard to your eyes, you must *always* wear protective goggles or face shields when using tools of this type. The high noise levels associated with these tools also requires hearing protection equipment as well.

Always check the rated speed of a grinding wheel before using; it should not be less than that of the machine or tool on which it is mounted. Grinders must have wheel guards to prevent injury.

To prevent a power tool from causing injury if it gets away from the user, the "deadman switch" automatically turns it off when not actually being held properly by the user. Always test this feature before operating a tool.

Radiation Hazard

As already discussed in the section about electrical and electronic safety, the high-powered radio-frequency (r-f) energy emitted by electronic transmitting equipment (such as radios or radars) can cause serious injury if you get too close to it. Areas where this hazard exists will have warning signs posted to help you remain clear.

If you must work on equipment of this type, be sure to follow all safety precautions. For example, you should never inspect a radar's wave guide (a kind of square pipe that carries the radar's r-f signal between the antenna and the other components) for damage while it is activated because a leak can mean serious exposure to damaging r-f energy.

Respect all posted r-f hazard signs. Never assume a piece of equipment is secured unless you are absolutely certain and precautions have been taken to ensure that it is not accidentally reenergized.

Be aware that r-f energy can also accidentally detonate or damage certain weapons. When these weapons are on deck or in other exposed areas for loading or maintenance, radiation hazard (RADHAZ) procedures will be put into effect. Follow all RADHAZ instructions and procedures, and if in doubt as to what you should or should not be doing, *ask*.

Radioactive Materials

Radioactive material is present in nuclear reactors and warheads, in the sources used for calibration of radiation-monitoring equipment, and in certain electronic tubes. Treat these objects with respect. Obey

radiation warning signs and remain clear of radiation barriers unless your job requires you to do otherwise.

Radiation sources must be installed in the radiation-detection equipment or stowed in their shipping containers in a locked storage area. Spare radioactive electronic tubes and fission chambers are stored in clearly marked containers and locked stowage.

Replenishment at Sea

Ships often come alongside one another to transfer fuel, ammunition, or stores; this is called underway replenishment (UNREP). Sometimes these transfers are accomplished by helicopters; this is vertical replenishment (VERTREP).

Safety regulations should always be reviewed immediately before each replenishment operation. Only essential personnel are allowed near any transfer station.

For UNREPs, topside personnel engaged in handling stores and lines must wear safety helmets and orange-colored, buoyant life-preserver vests. If the helmets are not equipped with a quick-acting breakaway device, you should fasten the chin strap *behind* your head or wear it unbuckled.

For VERTREPs, personnel may wear flight-deck vests and cranial impact helmets instead of the types used during UNREP.

Cargo handlers must wear safety shoes. Those handling wire-bound or banded cases wear work gloves.

If involved in a replenishment operation, be sure to keep clear of bights (loops) in the lines being used and keep at least six feet between you and any block (pulley) through which the lines pass. Keep clear of suspended loads and rig attachment points until loads have been landed on deck. Do not get between a suspended load and the rail or ship's superstructure. Be alert to the possibility of shifting cargo.

When line-throwing guns or bolos are used to throw lines between ships, the word will be passed just before the line is passed. If you are on the receiving ship, take cover while the line is being fired or thrown across.

Deck space near transfer stations should be covered with something slip-resistant.

During replenishments, a Sailor will be stationed well aft on the engaged side of the ship to act as a "lifebuoy watch." He or she will toss a life ring to anyone who falls or is knocked overboard and will immediately pass the word. Normally another ship will follow behind those involved in replenishment operations to act as a lifeguard ship

to retrieve anyone lost overboard. If no lifeguard ship is available, a boat or rescue helicopter should be kept ready for immediate use in rescuing anyone who falls overboard.

Measures must be taken to avoid hazards associated with r-f hazards. This is important when handling ammunition and petroleum products. Dangerous materials, such as acids, compressed gases, and hypochlorites, are transferred separately from one another and from other cargo.

When transferring personnel by highline, only double-braid polyester line (hand-tended by at least 25 people) is used. Persons being transferred wear orange-colored life-preservers (except patients in litters equipped with flotation gear). When the water temperature is 59° Fahrenheit or below, or when the combined outside air/water temperature is a total of 120° or below, immersion suits should be worn by personnel being transferred.

When fuels are received or transferred, no naked light (meaning all forms of oil lanterns, lighted candles, matches, cigars, cigarettes, cigarette lighters, and flame or arc welding and cutting apparatus) or electrical or mechanical apparatus likely to spark is permitted within 50 feet of an oil hose, an open fuel tank, the vent terminal from a fuel tank, or an area where fuel-oil vapors may be present. Portable electric lights used during fueling must have explosion-proof protected globes and must be inspected for proper insulation and tested prior to use. Portholes in the ship's structure on the engaged side are closed during fueling operations to prevent the accumulation of dangerous vapors inside the ship.

Safety Devices

Mechanical, electrical, and electronic safety devices must be inspected at intervals specified by the planned maintenance system (PMS), by type-commander instructions, or as usual circumstances or conditions warrant. When practical and safe, these inspections are conducted when the equipment or unit is in operation. Machinery or equipment should never be operated unless safety devices are working.

No one should tamper with or render ineffective any safety device, interlock, ground strap, or similar device without the commanding officer's approval.

Safety Tags

DANGER, CAUTION, OUT OF COMMISSION, and OUT OF CALIBRATION tags and labels must be posted for the safety of personnel and to prevent

misuse of equipment. Safety tags must never be removed without proper authorization.

Shore Power

When ships are moored to piers they will usually hook up to shore power instead of continuing to generate their own electricity as they must do at sea. This involves running heavy electric cables from the ship to terminal boxes on shore. Like all electrical equipment, that associated with shore power must be treated with great respect.

All on-board shore-power equipment must be checked for safety. Shore power cables should be thoroughly inspected before using. Spliced portable cables are dangerous and should not be used except in an emergency. Cables should be long enough to allow for the rise and fall of the tide, but not so long as to allow the cable to dip in the water or become wedged between the ship and the pier. Cables should not rest on sharp or ragged edges such as ship gunwales. Personnel should not step or walk on shore-power cables.

Smoking

Environmental Protection Agency findings, and the surgeon general's statement that smoking is the number-one preventable cause of death, have caused smoking policy revisions everywhere. DOD bans smoking tobacco products in all DOD workplaces worldwide. The Navy prohibits smoking in its ships, vehicles, and buildings with few exceptions.

On board ship, the CO may allow smoking on weather deck spaces as safety and operations permit, and in one or more normally unmanned spaces that ventilate directly out of the vessel. Smoking is not allowed in work spaces, watch stations, berthing areas, lounges, messing areas, libraries, ready rooms, exercise areas, and medical areas.

At shore facilities, smoking areas may be designated outdoors away from common areas used by nonsmokers. Smoking is allowed in individually assigned family and bachelor living quarters and designated lodge rooms when quarters are not serviced by a common heating/air-conditioning ventilation system.

Smokeless tobacco is prohibited during briefings, meetings, classes, formations, inspections, on watch, or whenever proper decorum is required.

Tanks and Voids

No one is permitted to enter any closed compartment, tank, void, or poorly ventilated space aboard a naval or Navy-operated ship until

the space has been ventilated and determined to be gas-free by a qualified gas-free engineer. In an emergency, if a space must be entered without gas freeing, a breathing apparatus such as an airline mask must be worn. In all cases, at least two persons must be present when such a space is occupied. One remains outside the space and acts as line tender and safety observer.

The space entered should be continuously ventilated, and a reliable person must be stationed at the entrance to keep count of the number of persons inside as well as to maintain communications. Suitable fire-extinguishing equipment must be on hand, nonsparking tools are to be used, and persons entering should not carry matches or lighters or wear articles of clothing that could cause a spark.

Toxic Materials

Solvents, refrigerants, paint thinner, fumigants, insecticides, paint removers, dry-cleaning fluids, antifreeze, and propellants for pressurized containers are all examples of toxic materials that may be hazardous if inhaled, absorbed through the skin, or swallowed. Even small amounts of some of these and similar substances can cause permanent blindness or death. The use of all hazardous materials is controlled by the medical officer or some other designated person. These substances should be used only in well-ventilated spaces, and contact with the skin should be avoided.

Welding

Welding is performed only with the permission of the commanding officer or officer of the deck. The area where "hot work" is done must be cleared of flammable matter beforehand. Fire watches are posted until materials cool.

Various synthetic materials yield toxic gases when burned or heated. Use caution when burning or welding resin-coated vinyl surfaces. Vinyl coating must be chipped or scraped clear in the work area whenever possible; welders, fire watchstanders, and others required to be in the immediate area are equipped with line respirators. Exhaust ventilation in the work area has a minimum capacity of 200 cubic feet per minute for each three-inch suction hose.

Although ship's personnel do not normally do welding work on the hull, if such work is required proper precautions must be taken and the hull must be x-rayed at the first opportunity to determine if any structural damage has taken place.

Personnel are always assigned to function as a "fire watch" for the purpose of detecting and immediately extinguishing fires caused by

welding operations. The watch usually consists of at least two persons—one with the operator, the other in the space behind, below, or above the site of cutting, grinding, or welding. Remember, heat generated by welding or burning passes through bulkheads and decks and can ignite material on the other side. If you are assigned as a fire watch, you must remain alert at all times, even though the assignment may grow boring. Make sure that the equipment you are issued is in working condition and, if you don't know how to operate it or have even minor questions, do not hesitate to ask for assistance. Inspect the work site with the welder. Make sure you know where all firefighting equipment is in the work space and adjoining spaces and know how to use it. Also make sure you know where and how to sound the fire alarm and know the assigned escape routes from the space.

When the hot-work operation is complete, fire watchstanders should inspect both sides of the work area and remain on station for at least 30 minutes to be sure that there are no more smoldering fires or sparks and that the hot metal has cooled to the touch.

Working Over the Side

At times it is necessary for work to be done over the side of a ship (such as rust removal or painting). No work is done over the side without the permission of the OOD. Crews working over the side on stages, boatswains' chairs, and work floats or boats wear buoyant life-preservers and are equipped with safety harnesses with lines tended from the deck above. When another ship comes alongside, all personnel working over the side should be cleared.

All tools, buckets, paint pots, and brushes used over the side must be secured by lanyards (pieces of line) to prevent loss overboard and injury to personnel below.

No person may work over the side while the ship is under way without permission of the commanding officer.

Emergencies

Despite all the safety precautions that are taken in the Navy, emergency situations will occasionally take place. The consequences of an emergency situation may depend to some degree upon luck and circumstances, but a major determining factor will be the preparedness and performance of the crew.

Because of this, shipboard drills will be frequently conducted so that you and the other members of the crew may prepare for those emergencies before they happen. Take advantage of these opportuni-

ties. They just may save your life or prevent serious injury some day.

General Quarters

During a major emergency—such as a serious fire or a gunboat attack—you will hear the continuous sounding of the general quarters alarm plus the words passed over the 1MC: "General quarters! General quarters! All hands man your battle stations!" If you hear this, don't try to find out what has happened. Just *move!* You will find out soon enough what is happening. Proceed as quickly as you can (being careful not to run into others or forget to duck when passing through low doors) to your assigned general quarters station. To ensure a smooth flow to stations, everyone adheres to the rule of "FUSDAP"—forward, up starboard; down, aft, port. This means that if you need to go forward or up to get to your general quarters station, you should move to the starboard side of the ship. Conversely, if you need to move aft or down to a lower level, you must go the port side of the ship. This will keep people from running into each other as they hurry to their stations. When everyone on board is at his or her battle (general quarters) station, the ship is most prepared for any emergency that may occur.

Man Overboard

When someone goes overboard, prompt action is essential. If you see someone go overboard, immediately sound the alarm, "Man overboard, port [starboard] side," and throw a life ring or life-jacket. If a smoke float and a dye marker are available, drop them in, too. If possible, keep the person in sight. Everyone who sees the individual in the water should point at him or her. This will help the conning officer to bring the ship around to make a speedy recovery.

Every underway watch is organized to handle this situation. The conning officer maneuvers the ship to a recovery position. At the same time, the word is passed twice over the ship's 1MC system, and six or more short blasts are sounded on the ship's whistle. The lifeboat crew stands by to lower away when directed. If available, a helicopter may be launched. If the identity of the person is not known, a muster of the crew will be held to find out who is missing.

If *you* are the person who falls overboard, make every effort to keep your head. Hold your breath when you hit the water; the buoyancy of your lungs will bring you to the surface. There is an old wives' tale that says the ship's screws will suck you under if you are

too close to the ship. Because this isn't true, you should not waste your valuable energy by swimming frantically away from the ship. Use your energy to stay afloat and try to stay in one place. The ship will maneuver right back down her track toward you. (*Note:* The exact placement of a person overboard is pinpointed in the combat information center using a dead-reckoning tracer.) Even if no one saw you go over, keep afloat and conserve your energy. Fight the impulse to panic. When a shipmate is missed, ships and aircraft begin an intensive search.

If a person goes overboard in port, the alarm is sounded as usual and the OOD follows the best available rescue procedure. Boats in the water assist in the emergency.

CBR Attack

In modern warfare, it is possible that an enemy may resort to what are commonly referred to as unconventional weapons. In the Navy, these are called CBR weapons, which stands for chemical, biological, and radiological. While these weapons are very different in some ways, many of the defensive measures employed against them are the same. In the event of a CBR attack, the crew can do a great deal to minimize casualties and damage.

For those ships located at or near "ground zero" (the point of detonation) in a nuclear attack, or in an area of high concentration of biological or chemical agents, casualties and damage will, of course, be great. However, tests have shown that ships not receiving the direct effects of such attacks have a good chance of survival with relatively few casualties, and with weapons systems intact. If a formation of ships is widely dispersed as a defensive measure, it is probable that nearly all fleet units will escape the direct effects of a CBR attack.

Protecting the Ship

When a CBR attack is expected, the ship will go to general quarters and all topside areas will be washed down using the built-in water wash-down system. The entire outer surface of the ship is kept wet so that CBR contaminants will wash overboard and not adhere to the external surfaces of the ship.

All nonvital openings of the ship are closed to maintain an envelope as gas-tight as possible. Some areas of the ship (such as engineering spaces) must continue to receive air from the outside; personnel who are manning stations in those spaces will have gas masks readily available.

Chemical-warfare directional detector sensor units are operated by signalmen on the signal bridge. The AN/KAS 1 sensor unit uses infrared sensing to indicate the presence and location of chemical clouds.

Protecting Personnel

The extreme effectiveness of some bacteriological agents, the toxicity of chemical agents, and the danger of radioactive fallout mean that protective clothing must be worn to increase the chances of survival. It is also essential that this clothing be worn properly, so it is mandatory that all personnel be periodically retrained in the use of protective clothing and masks.

The CPO Suit. The "chemical protective overgarment" (often called a "CPO suit") effectively protects against all biological and chemical agents for at least six hours of exposure. The CPO suit is *not* to be used for radiological contamination, however. It consists of a parka (smock) and trousers, with two layers of material: an inner (antigas charcoal absorbent) and an outer (modacrylic/nylon) which protects against liquid agents. The parka has a sleeve patch that

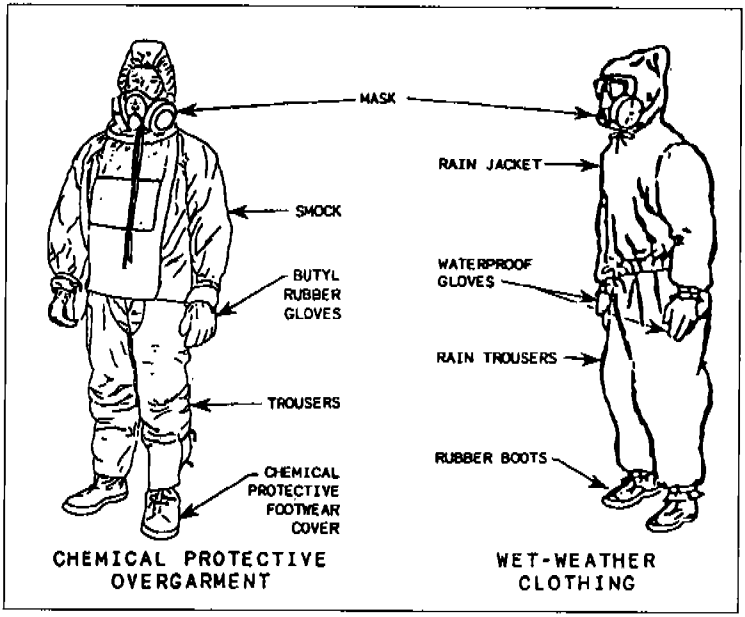


Figure 17.2. The CPO suit and foul-weather gear provide protection against some CBR contaminants.

holds detector paper which will indicate the presence of toxins. Adjustments are made by velcro fastenings at wrist, waist, and ankle. The CPO is issued in a sealed plastic envelope.

Foul-Weather Gear. Aboard ship, wet-weather clothing (often referred to as "foul-weather gear") is available for working outside in heavy rains and seas. This clothing—consisting of a parka with hood, overalls, rubber boots, and waterproof gloves—provides some extra protection during a CBR attack. When worn with normal battle-dress clothing, it will protect you from all but the most potent forms of radiological effects. When worn with the CPO suit, it provides an extra layer of protection from chemical and biological agents.

Protective Masks. Several protective masks are available for general use in the Navy, and some can be used in CBR defense. Masks are generally of two types: those that have a closed breathing system that actually supplies oxygen to the user and those that do not provide oxygen to the user but employ mechanical and chemical filters that remove solid or liquid particles and absorb or neutralize toxic and irritating vapors.

The oxygen-breathing apparatus (OBA) (see chapter 18, "Damage Control") is an example of the first type of mask. The chemicals in

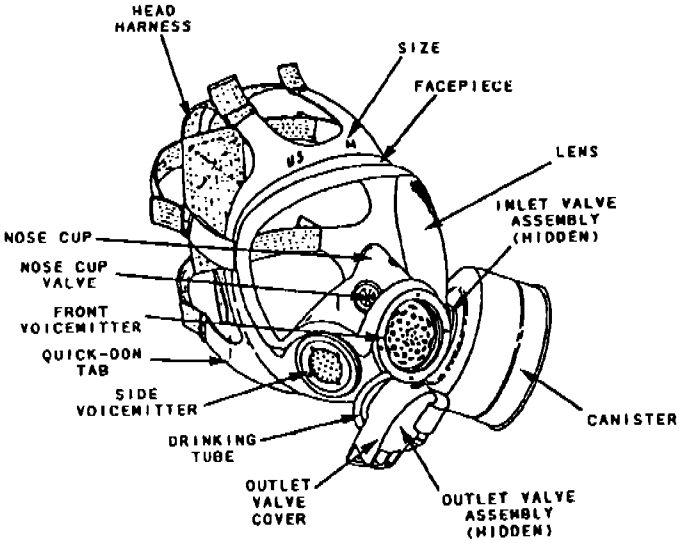


Figure 17.3. The MCU-2P gas mask. Note the front voicemitter used in face-to-face communications and the side voicemitter used with communication equipment.

the OBA canister provide oxygen for about 45 minutes of light activity or 30 minutes of heavy work.

The MCU-2P gas mask is a good example of the second type. Its filters will protect against the inhalation of harmful chemical, biological, and radiological agents. The filters are issued separately and must be periodically replaced. It is important to remember that this type of mask will not protect you against carbon monoxide, carbon dioxide, ammonia, and many fuel gases or vapors. This mask is not used in connection with firefighting or smoke, or in an atmosphere containing less than 20.8 percent oxygen, the amount necessary to support life. In these cases, the OBA or some other type of oxygen-supplying mask is what you want.

Mission-Oriented Protective Posture (MOPP). Because protective clothing can be cumbersome and hot, and it interferes with basic human needs and functions, the MOPP system provides a standardized system that permits the commanding officer a means of choosing—depending upon the level of threat—the best balance between comfort and protection. The higher the risk of CBR attack, the higher the MOPP number that will be put into effect (see Table 17.1).

Detection of CBR Contaminants

The detection of CBR agents—which generally are invisible, odorless, tasteless, and give no hint to the senses of their presence—requires special equipment and training.

Table 17.1. MOPP Levels for CBR Attacks

MOPP Level	*Protective Measure to be Taken*
1	Protective equipment is issued to crew. Each crew member adjusts her/his mask for proper fit and stows it. Protective suits and filters for masks are located at battle stations.
2	Protective suits are put on. Hood is left down. Mask is either carried or its location is known and readily available.
3	Suit (with hood down) and boots are worn. Mask is fitted with fresh filter canisters. Mask and gloves are carried.
4	All protective equipment is worn. Hood is put up and secured around mask.

Radioactive particles betray their presence by giving off several kinds of radiation, which can be detected by instruments known as radiacs (radiation, detection, indication, and computation). These instruments can be personal dosimeters, which measure the amount of radiation a person has been exposed to, or they can be survey instruments used to detect the accumulated radiation in various parts of the ship.

In biological-warfare detection, samples must be taken, cultured, and subjected to thorough laboratory testing before the agent can be identified. This is slow, exacting work; if viruses are involved, they can greatly increase the difficulty of identification. Since identification is difficult, by the time the agent has been identified there could already be many casualties.

Chemical agents are somewhat easier to detect, but no one procedure can detect all known chemical agents. Some of these are lethal in extremely small concentrations and hence could be deployed upwind over a great area with devastating results.

The monitoring and surveying of ships and stations is a vital part of CBR defense. Locating a hazard, isolating contaminated areas, recording the results of a survey, and reporting findings up the chain of command are the functions of every military unit encountering contamination.

Decontamination

With early detection of CBR contamination, many lives can be saved by prompt and efficient decontamination. One of the most effective methods is flushing the contaminated surfaces with large amounts of water. The water wash-down system can be used for external surfaces, along with a more thorough subsequent scrubbing by personnel wearing protective clothing. For internal contamination, fire hoses and manual scrubbing are employed. Steam is also a useful agent for decontamination, especially if biological-warfare agents are suspected or if the contamination is lodged in greasy or oily films.

Emergency Destruction

In the event that your ship or station is in serious danger of being overrun or captured by enemy forces, the commanding officer may order the destruction of classified documents and equipment to prevent their falling into enemy hands. There are specific procedures for this unpleasant business and special equipment has been created for this purpose. As with all potential emergency situations, periodic drills will be conducted so that all involved personnel will be ready to carry out their duties in an expeditious manner.

Abandon Ship

Despite all precautions to prevent such a catastrophe, ships can sometimes be so badly damaged by battle or fire or some other cause that it becomes necessary for the crew to leave the ship before it sinks. During an emergency of this sort, many senior officers and petty officers may be lost as battle casualties, so you may find yourself with less supervision and assistance than usual. It is, therefore, a good idea to make sure you have a clear picture in your mind what you should do in the event the decision is made to abandon ship. Know your abandon-ship station and duties. Know all escape routes to the ship's topside from berthing spaces or working spaces below decks. Know how to inflate a life-jacket. Know how to lower a boat or let go of a life-raft. Know how to handle survival gear. And know how to do all of this *in the dark!* Disaster can strike suddenly at sea. A ship can go down within three minutes of a collision or explosion. If you don't know what to do before this happens, there won't be time to find out after it does.

Abandon-ship stations and duties are noted on the WQ&S bill. Careful planning is required to determine who goes in which boat or raft, what emergency equipment is to be supplied, and who supplies it.

Only the commanding officer can order abandon ship. She or he will do so only after all efforts to save the ship prove futile. If the commanding officer is killed or incapacitated, the executive officer or next senior surviving officer will take command and make this decision if necessary.

When the abandon-ship alarm sounds, act fast. Always wear a soft cover hat. Take note of important information, such as bearings and distance to nearest land and the water temperature. If there is time, this information will be passed to everyone by bridge personnel.

Going Over the Side

Make certain your life-jacket is secured properly and is equipped with a whistle, dye marker, and chemical lights. Go down a cargo net, boat falls, fire hose, or line if you can, but don't slide down and burn your hands. If you have to jump, look out for wreckage or swimmers in the water. Don't dive head-first into the water; jump feet-first, with legs crossed and arms crossed across your chest, firmly gripping your triceps. If you have a pneumatic life-jacket, don't inflate it until you are in the water—otherwise you will pop right out of it and possibly injure yourself because of the extreme buoyancy and force an inflated jacket exerts on your neck and body.

If possible, go over the windward side (in other words, jump into the wind) and swim upwind. If you go over the leeward side (side opposite the wind), the wind may blow the ship or burning oil down on you. Swim underwater to avoid burning oil; when you come up for air, splash the oil away as you break the surface. To protect yourself from underwater explosions, swim away for at least 150 yards, then climb aboard a raft, boat, or piece of wreckage, or float on your back. Stay calm.

In the Water

Rafts, boats, nets, and floating wreckage should be tied together; this makes it easier for searchers to find you. Wounded personnel should be put in boats or rafts first. Those strong enough to do so should hang on the sides if overcrowding is a problem.

In cold water, everyone must get into a raft or boat as soon as possible. If you must remain in the water, stay as still as possible to prevent heat loss. Heat escapes most rapidly from the head, hands, and feet; use whatever clothing is available to protect these areas. Numbness occurs in waters below 35° Fahrenheit. Breathe slowly and remain still. If overcrowding is a problem in cold waters, you may have to follow a rotation plan to get uninjured persons in and out of life-rafts. Frostbite and immersion foot can occur quickly in cold water. Don't rub, as this will damage frozen tissues. Warm affected parts against your own body or a shipmate's.

In a hot climate, keep your shirt, trousers, and shoes on—you'll need them for protection against sun and saltwater.

Boat Handling

In a power boat, the slowest possible speed will give the best mileage. If the boat is fitted for sails, use them and save the motor for an emergency. Otherwise, jury-rig a mast and sails out of oars, boat hooks, clothing, and tarpaulins. If wind and sea are driving you away from the nearest land or rescue area, rig a sea anchor (something dragged along behind the boat or raft in the water) to slow the drift.

Organization

The abandon-ship bill assigns an officer or senior enlisted person to each boat or raft, but serious casualties may make you the senior person in a boat. If so, take charge.

Make the wounded as comfortable as possible. Make a list of all survivors, and try to list all known casualties. Inventory all water and provisions and set up a ration system based on the expected

number of days to land. No one should eat or drink for the first 24 hours.

Organize a watch. Lookouts must be alert and know how to use available signal gear. Get underway for the nearest known land or well-traveled shipping route. Time permitting, the nearest landfall and coordinates by compass will be passed over the 1MC. Each boat and raft will be equipped with a compass.

Secure all gear so nothing will be lost. If you have fishing gear aboard, use it; otherwise, make some. Rig a tarp for protection against the sun and to catch rainwater.

Try to keep all hands alert and cheerful. Save energy; unnecessary exertion uses up food and water.

Equipment

The vest-type life-preserver is the most important item of abandon-ship equipment. Learn how to use it. The vest preserver goes over other clothes. Adjust the chest strap and fasten the snap hook into the ring; tie collar tapes to keep them down under your chin; and pull straps between the legs from behind, as tightly as possible without becoming uncomfortable. Adjust the straps on an unconscious person before he or she is put overboard; the design of this preserver will keep the person's head upright and prevent drowning.

The inflatable life-preserver is carried in a pouch at your back and fastens around your waist on a web belt. It can be inflated with a carbon-dioxide cartridge or by blowing into the attached hose. To inflate the preserver, pull the pouch around in front, remove the preserver, slip it over your head, and jerk the lanyard down as far as possible to release the gas into the chamber. For more buoyancy, you can add air through the mouthpiece of the oral inflation tube. To reduce buoyancy, open the valve on the tube. Never attempt deflation with the tube in your mouth.

The twenty-five-man Mark 6 inflatable lifeboat, the type carried aboard most ships, is a compact, relatively light, easily stowed, and easily launched boat. It is constructed of separate tubes so that if one or more is punctured the boat will still retain some buoyancy. The upper, lower, and canopy support tubes are inflated by carbon-dioxide cylinders; the thwart tubes are inflated with hand pumps. A fabric bottom is attached to the lower tube to support manually inflatable decks, which are equipped with hand lines and are removable for emergency use.

The boat has a carrying case with a release cable extending outside; pulling the cables will open and inflate the boat in about 30 sec-

A. LIFE PRESERVER DONNED JACKET TIED AT UPPER CHEST AND WAIST; WAIST TIE PULLED SNUG, SNAP HOOK BEING FASTENED INTO RING ON CHEST STRAP.

B. LEG STRAPS BEING REMOVED FROM BACK OF PERSERVER; WILL BE LED BETWEEN LEGS.

C. BOTH STRAPS PULLED BETWEEN LEGS, ONE FASTENED TO D RING ON LEFT SIDE, OTHER BEING FASTENED.

D. TYING THE COLLAR.

Figure 17.4 a-d. Donning the vest-type life preserver.

onds. Normally the boat should be inflated in the water. As soon as the boat is inflated, use the boarding net and grab ladders to board it. The first person to enter stays at the entrance to help others; the second aboard goes forward to open the opposite entrance, check the sea anchor, and help others board at that end.

Secured inside the boat is a waterproof equipment container filled with survival gear, including the following items: food-ration packets, canned water, can openers, de-salter kits, water-storage bags, batteries, sea dye marker, mirror, sponges, pocket knife, whistle, mea-

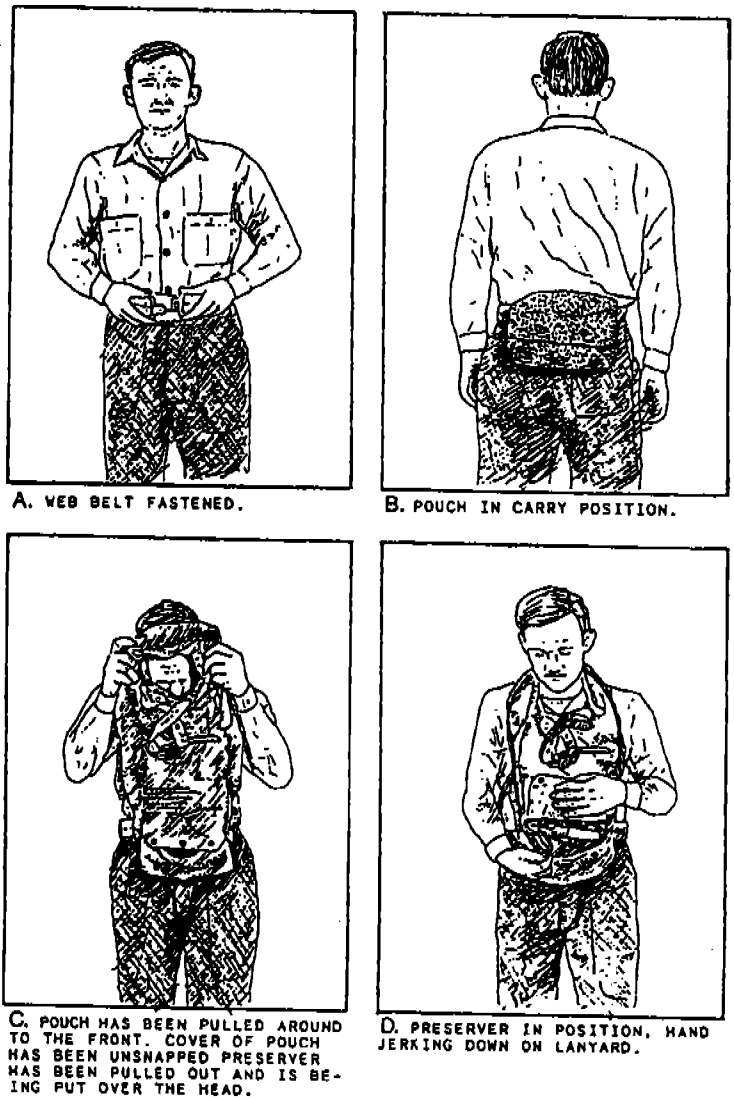


Figure 17.5 a-d. The inflatable life preserver.

suring cup, motion-sickness tablets, two-quart bailer, first-aid kit, signaling kit, fishing kit, and five flashlights.

The signaling equipment is extremely important because life-rafts are difficult to spot from the air and from the surface in heavy weather. The signal mirror you will find among the supplies pro-

vided, if used properly, can be seen at a distance of 10 miles or more. To be effective, you must hold the mirror so that it reflects sunlight onto a nearby object. Then looking through the hole in the center of the mirror, you will see a bright spot that shows the direction of the reflected beam of sunlight. Keep your eye on the dot and move the mirror slowly until the dot is on the target.

The signal kit also contains Mark 13 distress signals for day and night use, which can also be used to provide wind-drift information to helicopters that have come to rescue you. One end of the signal tube produces an orange smoke for day use; the other end produces a red flare for night use. If it is very dark, you can tell which end is the flare by feeling the series of small beadlike projections embossed around the edge. Each signal will burn for about 18 seconds.

Dye markers have a powder that produces a brilliant yellowish-green fluorescence when sprinkled on the water. In good conditions, the dye will be best seen for about an hour, but it will retain some of its color for up to four hours. From an altitude of 3000 feet, the detection range of the dye marker may be as great as 10 miles. The range decreases as the dye deteriorates. Unless the moonlight is very bright, the dye is not effective at night.

Because water is essential for life, and seawater is not fit for consumption, you should never discard any article that will hold water. When it rains, every container that can hold water will be invaluable. To assist you in filling the containers, a rain-catcher tube is attached to the lifeboat canopy. Some types of rafts, such as those carried in aircraft, have primitive but effective solar stills for converting seawater into fresh water. In polar areas, fresh water can be obtained from old sea ice, which is bluish, splinters easily, and is nearly free from salt. Fresh water may also be obtained from icebergs, but be careful. As the berg's underwater portion melts, it gets top-heavy and can capsize without warning.

Fire

When fire breaks out on board a ship, the ship's bell is rung rapidly to get everyone's attention. At the end of the ringing, the bell is struck once distinctly to indicate that the fire is in the forward third of the ship, twice if the fire is in the middle third of the ship, or three times to indicate that the fire is in the after third of the ship. The word is then passed twice over the 1MC system, giving the exact location of the fire by compartment number and name if known.

If you discover a fire, it is vital for you to get the word to the bridge (if the ship is at sea) or the quarterdeck (in port). Always

report the fire first, then take action to fight it if you can. If anyone else is around, you may send them to report the fire while you fight it, but do not make the mistake of trying to put out the fire without first making sure that it is reported. Too often, a fire has gotten out of control because a person tried to put it out without calling for help.

If you have begun to fight the fire, do not leave the scene until the fire or repair party arrives, unless you are endangered and must leave the scene for your safety. (See chapter 18, "Damage Control," for more details on firefighting.)

18

Damage Control

Damage control (DC) is every Sailor's job—no matter what his or her rate or paygrade. A ship's ability to do her job, and indeed her survivability, may someday depend on her crew's damage-control response. Because basic DC qualification is a requirement for everyone on board, one of the first things a newly reporting individual receives is his or her damage-control personal qualification (PQS) package. This training package will guide you in learning about your ship, learning how to fight fires and control flooding, and reviewing basic first aid and the proper use of the ship's damage-control equipment.

The two major elements of damage control aboard ship are fighting fires and controlling flooding. The latter is often described as maintaining the ship's watertight integrity. To accomplish these vital tasks, you need to have an understanding of some basic principles of flooding, combustion, and the Navy's DC organization. You also need to know how to work with equipment that you most likely never heard of before joining the Navy. You may also have to find in your-

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Figure 18.1. Fighting fires is one of the two major elements of damage control aboard ship.

self an extra measure of courage and cool-headedness under pressure. Doing what is needed in a damage-control situation—with thousands of gallons of water rushing into a compartment you are trying to save, or the roar and heat of flames just a few feet away as you try to put down a fuel fire—can be a frightening experience. But if you prepare yourself by making sure that you know what is expected of you in case a DC situation arises, you will be able to keep your head in these stressful situations. Knowledge—understanding what the dangers are and how to combat them—is the most important ingredient to courage.

Damage-Control Organization

The damage-control assistant (DCA) usually answers directly to the chief engineer and is responsible for preventing and repairing damage, training the crew in damage control, and caring for equipment and piping systems assigned to the organization.

The ship's DC organization consists of two elements: the damage-control administrative organization and the battle organization. The former exists primarily to *prevent* damage on a routine basis while the latter is called into action to *control* damage once a problem has occurred.

DC Administrative Organization

To prevent or minimize damage, the ship will have an administrative organization in place to ensure that all DC-related preventive maintenance is accomplished on a routine basis. Each division in the ship will designate a damage-control petty officer (DCPO). Under the supervision of the DCA and his or her specially trained DC personnel, these DCPOs will:

Inspect division spaces daily for fire hazards and cleanliness;

Perform preventive maintenance on selected damage-control systems and equipment, portable firefighting equipment, and access closures (doors, hatches, scuttles) within their division spaces;

Maintain compartment checkoff lists and the setting of specified material conditions of readiness within their division spaces; and

Aid in teaching division Sailors damage-control, firefighting, and chemical-biological-radiological (CBR) warfare defense procedures.

DC Battle Organization

The ship's damage-control battle organization is directed from Damage Control Central (DCC) and includes a number (depending upon the size and mission of the ship) of repair parties and battle dressing stations (BDSs). DCC is the battle station for the DCA. To aid the DCA and his assistants in coordinating the damage-control activities of the ship, DCC is equipped with a variety of graphic displays that show the subdivisions of the ship and her systems. These displays include:

A casualty board to visualize damage and any corrective action in progress (based on repair-party reports);
A piping diagram and stability board showing the vessel's liquid loading status, the location of flooding boundaries, the effect of flooding and liquid transfer on the ship's list and trim, and the corrective action taken;
A corrective damage-control status board;
An electrical systems status board;
An electronic casualty status board; and
Deck plans to show areas contaminated by CBR agents, the location of battle dressing stations and decontamination stations, and safe routes to them.

Repair Parties

A key element in the damage-control battle organization is the repair party, the primary unit in the damage-control organization. Parties may be subdivided and spread out to cover a greater area more rapidly, and to prevent loss of the entire party from a single hit. The number and ratings of personnel assigned to a repair party, as specified in the battle bill, are determined by the location of the station, the size of the area assigned to that station, and the total number of personnel available for all stations.

Each repair party will usually have an officer or chief petty officer in charge (called the repair locker officer or repair party leader), a scene leader to supervise all on-scene activities (who also functions as the assistant repair-party leader), a phone talker, several OBA (oxygen-breathing apparatus) or Scott Air-Pak 4.5 personnel, and a number of messengers. The repair party is rounded out by additional petty officers and nonrated persons from various departments, such as electrician's mates (EMs), hull technicians (HTs), storekeepers (SKs), and hospital corpsmen (HMs).

Typical repair parties and teams are often designated as follows:

Repair 1. Main-deck repair. Includes a number of boatswain's mates who are familiar with the winches, capstans, and other equipment found on the ship's main deck.

Repair 2. Forward repair. Covers the forward third (roughly) of the ship's interior spaces.

Repair 3. After repair. Covers the after third (roughly) of the ship's interior spaces.

Repair 4. Amidship repair. Covers the middle third (roughly) of the ship (excluding engineering spaces).

Repair 5. Propulsion repair. Covers the engineering spaces of the ship. Comprised of an engineering officer or chief and a broad cross-section of engineering ratings. Personnel assigned to Repair 5 must be qualified in the various engineering watchstations, as well as highly proficient in damage-control skills.

Repair 6. Ordnance repair. Comprised primarily of gunner's mates, fire-control technicians, and electrician mates. Responsible for damage control and emergency repairs to the ship's weapons systems and magazines. This party is sometimes subdivided into forward and after groups.

Repair 7. Gallery deck and island structure repair. This unit is used primarily on aircraft carriers and other ship types where it is needed.

Repair 8. Electronics repair. Comprised primarily of personnel with ratings in the various electronic specialties (ETs, FTs, STs, and EWs).

Because of their special needs, aircraft carriers and ships equipped for helicopter operations also have aviation-fuel repair teams and crash and salvage teams.

Ships that carry large amounts of ordnance (ammunition ships and aircraft carriers, for example), have an explosive ordnance disposal (EOD) team made up of specially qualified personnel. These highly trained individuals are capable of disarming fuzed bombs and taking care of other ordnance-related emergencies. The EOD team is usually administered as a part of the ship's weapons department.

Within each repair party there are hose teams; de-watering, plugging, and patching teams; investigation teams; shoring, pipe repair,

structural repair, casualty power, interior-communications (IC) repair, and electrical repair teams; chemical detection, biological sampling, radiological monitoring, and CBR decontamination teams; and stretcher bearers.

In general, repair parties must be capable of the following:

Maintaining watertight integrity (preventing leaks and flooding).
Maintaining the ship's structural integrity (shoring up weakened decks and bulkheads).
Controlling and extinguishing all types of fires.
Giving first aid and transporting the injured to BDSs.
Detecting, identifying, and measuring the amount of chemical, biological, and/or radiation contamination, as well as carrying out decontamination procedures.
Evaluating and reporting correctly on the extent of damage in an area.

The equipment needed by repair parties is stowed in repair lockers. Included are such things as patches for ruptured water and steam lines, broken seams, and the hull; plugs made of soft wood for stopping the flow of liquids in a damaged hull or in broken pipes; assorted pieces of wood used for shoring; radiological defense equipment; an electrical repair kit for isolating damaged circuits and restoring power; and tools for forcible entry, such as axes, crowbars, wrecking bars, claw tools, hacksaws, bolt cutters, oxyacetylene cutting torches, and portable exothermic cutting units. The equipment stowed in a repair locker is reserved for damage control only and should never be used for any other purpose.

Communication is vital to the damage-control organization. Systems used by repair parties and the DCA to communicate include battle telephone (sound-powered) circuits, interstation two-way (MC) systems, ship's service telephones, the internal voice communication system (IVCS), wire-free communication (WFCOM), and messengers.

Battle Dressing and Decontamination Stations (BDSs)

Most ships have at least two BDSs equipped to handle personnel casualties. They are manned by medical personnel and are located so that stretcher cases may be brought directly to them by the repair party. Emergency supplies of medical equipment are also placed in first-aid boxes throughout the ship. Signs are also posted throughout the ship directing you to the nearest BDS.

To handle CBR problems, at least two "decontamination stations" are provided in widely separated parts of the ship, preferably near BDSs. Signs pointing the way to these stations are painted with photoluminescent markings so that they can be seen in low-light conditions. To prevent recontamination after personnel have been decontaminated, each station is divided into two areas: a clean section, and a contaminated or unclean section with a washing area. Stations are manned by trained medical and repair-party personnel to ensure that proper decontamination procedures are followed.

Watertight Integrity

A ship cannot survive without maintaining its watertight integrity. Leaking or flooding in a ship obviously leads to its sinking. For this reason ships are designed so that damage resulting in leaks or flooding can be controlled and its effects minimized. Because of these design features, ships can experience an amazing amount of damage and still survive if proper precautions are taken in advance and the right corrective action is taken once damage is sustained.

Compartmentation

As explained in an earlier chapter, a network of bulkheads and decks—designed to prevent the flow of water or other fluids from one space to another when they are properly secured—ensures that a ship is protected from sinking. If one compartment experiences flooding, it can be sealed off from the others so that little of the ship's overall buoyancy is affected, thus reducing the danger of sinking. If a ship did not have this protection, one leak would cause the eventual sinking of the ship.

A ship is divided into as many watertight compartments as practical. In general, the more watertight compartments a ship has, the greater her resistance to sinking. This system, which permits the isolation of individual compartments, is useful not only to control flooding, but also to prevent the spread of fire and smoke and to reduce the effectiveness of CBR attacks.

Closures

For ideal buoyancy and protection against fire and other dangers, each compartment within a ship would be completely sealed up all of the time. This is obviously not practical since it would mean that no one could ever enter or leave a space on a ship. In order for a ship to function, it must have openings to permit passage through bulkheads and decks.

Because an opening in a deck or bulkhead obviously compromises watertight integrity, these openings must have closures (also called fittings) that can be used to restore watertight integrity when it is needed.

In ships, these closures are called *watertight doors* (WTD) when they seal openings in bulkheads, and *hatches* when they seal openings in decks.

Doors

Watertight doors are designed to resist the same amount of pressure as the bulkheads they are a part of. WTDs are sealed shut by rubber gaskets which are fixed to the door in such a way as to create a seal between the door and bulkhead where they come into contact. This point of contact is called the *knife edge*. The "latches" that press the door shut and hold it there are called *dogs*.

On a WTD, the dogs will be placed all around the door to ensure a proper seal. Some doors have dogs that must be individually closed and opened. Others, known as *quick-acting watertight doors,* have mechanisms that operate all dogs simultaneously. Some doors, because of their location, do not need to be watertight. These are, not surprisingly, called *nonwatertight doors* (NWTD).

Some doors, though not watertight, are *airtight* (ATD) to retard the spread of flames or gases. Some doors have small tubelike openings in them which allow ammunition to be passed through without having to open the whole door. These are called *passing scuttles*.

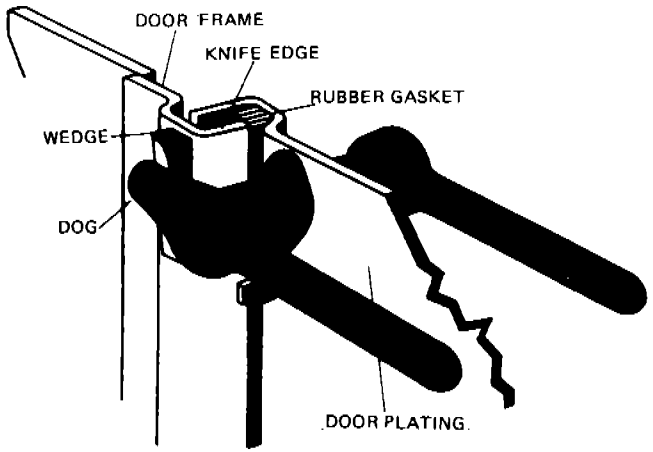


Figure 18.2. This cutaway section of a watertight door shows how the knife edge presses against the rubber gasket for a tight seal.

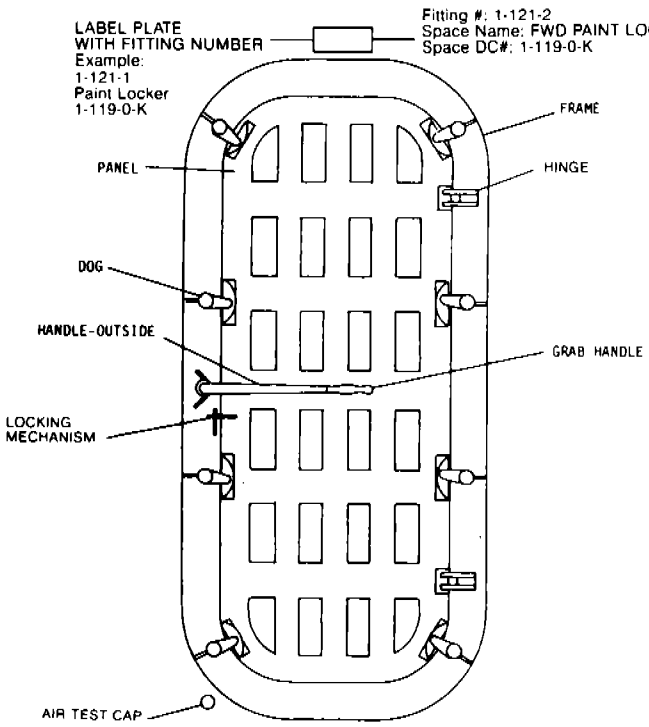


Figure 18.3. An outside view of a quick-acting watertight door. Note the dogs all the way around for a tight seal.

Some openings, such as between offices, do not require watertight integrity and the doors they have look and function like normal doors you are used to seeing in buildings ashore. These are called *joiner doors*.

Hatches

Hatches can be thought of as horizontal doors that close the openings that allow access between decks. A hatch is either set with its top surface flush with the deck or on a *coaming* raised above the deck. The latter is preferable in an area (such as on a weather deck) where water might frequently wash over the deck. The coaming provides some protection that will prevent much of the water from pouring into the compartment below.

Some hatches, because they must cover relatively large openings in the deck, are heavy and difficult for one person to handle. To take

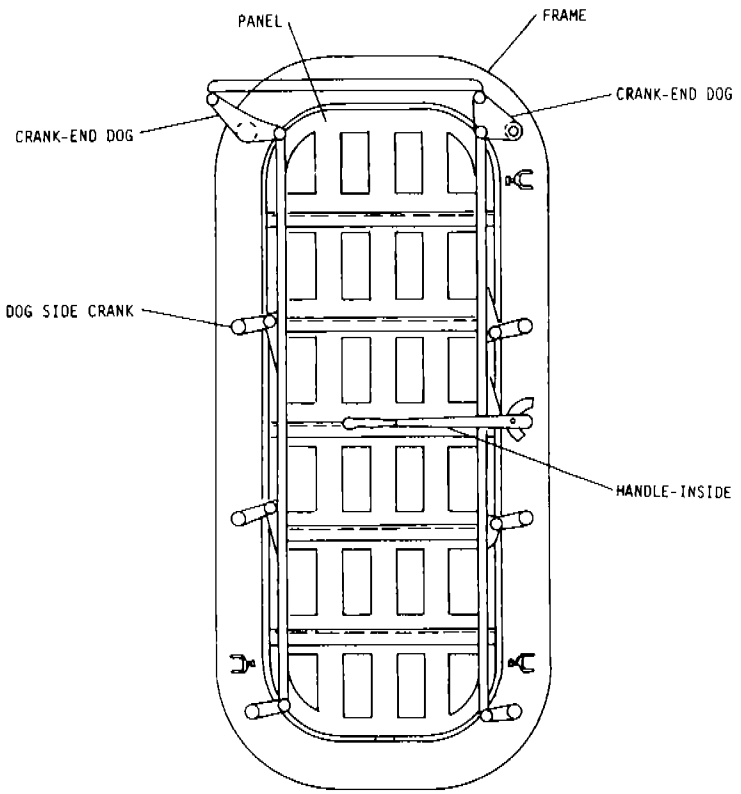


Figure 18.4. An inside view of a quick-acting watertight door, showing how the dogs are linked together for simultaneous opening and closing.

care of this problem, larger hatches have an *escape scuttle*. This is a round opening with quick-acting closures that can be placed in a hatch (and sometimes in a bulkhead or deck) to permit rapid escape from a compartment.

Manholes provide access to spaces that must be entered only on rare occasions, such as voids and tanks used to store water and fuel. The covers to these openings are normally bolted in place. Manholes are also occasionally placed in bulkheads.

Other Fittings

Certain other fittings must be closed at times to prevent the unwanted flow of air or fluids. These would include certain valves and vents. For example, if an enemy aircraft sprays your ship with a toxic gas,

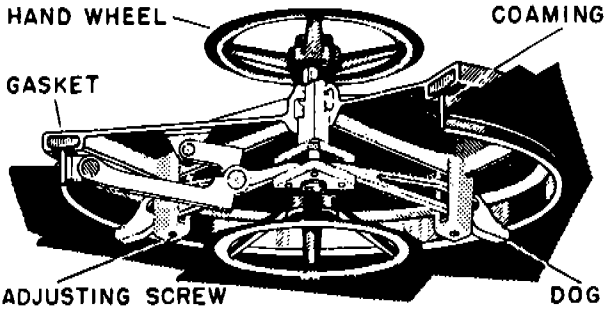


Figure 18.5. A cutaway section of an escape scuttle showing the quick-acting handwheels above and below.

it would be necessary to close the vents that bring air into the ship until the danger has passed.

Compartment Checkoff Lists

In every compartment, posted where it can easily be seen, is a compartment checkoff list. This list tells you every DC fitting (hatch, door, valve, vent, and so on) in that compartment. It also tells which division is responsible for that fitting, where it is located, and what it is used for. Other useful information, such as a list of all DC equipment (for example, fire extinguishers and hoses) is also included on this list. If you are familiar with the Navy's method of numbering compartments, you will find this checkoff list very useful in locating important fittings and equipment. It is a good idea to take the time to study the compartment checkoff list in those compartments in which you spend a lot of time (such as your berthing compartment or work spaces), so that you will know what types of damage-control fittings and equipment are in those compartments and where you can find them in an emergency.

Maintenance and Usage of Closures

All doors, hatches, scuttles, and manholes giving access to compartments must be securely "dogged" (closed down). Manhole covers should always be bolted except for inspection, cleaning, or painting. They must never be left open overnight or unattended when crews are not actually working in them.

Watertight doors and hatches will work longer and require less maintenance if they are properly closed and opened. When closing a door, first set a dog opposite the hinges, with just enough pressure to

keep the door shut. Then set a dog opposite the first one. Close the others, making sure you work with opposites as you go. This will maintain uniform pressure all around.

When opening a door, start with the dogs nearest the hinges. This procedure will keep the door from springing and make it easier to operate the remaining dogs. Open the rest as you would when closing, shifting to opposite sides as you go.

Never paint the gaskets—the rubber must remain pliable for a proper seal—and never strike a knife edge—dents or burrs will prevent a proper seal.

When the ship sustains damage, watertight doors, hatches, scuttles, and manholes should be opened only after making sure that the compartment is dry, or nearly so, to prevent further flooding when the closures are opened. Closures should not be opened without permission from DCC. Extra caution is always necessary in opening compartments below the waterline.

Material Conditions of Readiness

In order to determine when a ship's fittings should be opened for convenience and when they should be closed for safety, the Navy has devised a standardized system called the "material condition of readiness" system. This formal system permits the ship flexibility in adjusting to changing situations and thereby providing the right compromise between adequate safety and practical need. It should be fairly obvious, for example, that a ship at sea in a powerful storm is going to require a great deal more protection from flooding than is a ship moored to a pier in a safe harbor. To allow this flexibility, Navy ships have three material conditions of readiness that can be set to accommodate various situations, each representing a different degree of tightness and protection. These conditions are called X-RAY, YOKE, and ZEBRA. The various closures on a ship have damage-control markings on them to identify which ones should be closed depending upon the material condition of readiness in effect.

Condition X-RAY provides the least protection but the most convenience. It is set when the ship is in little or no danger of attack, such as when she is at anchor in a well-protected harbor or secured at home base during regular working hours. During this condition, all closures (such as doors and hatches) marked with a black or circled *X* are secured. They remain closed when setting the higher conditions of readiness YOKE and ZEBRA.

Condition YOKE provides somewhat more protection than condition X-RAY and is set when a ship is involved in routine underway

operations. In port, YOKE is set after regular working hours and is also maintained at all times during war. YOKE closures, marked with a black or circled *Y*, are secured during conditions YOKE and ZEBRA.

Condition ZEBRA provides the maximum protection and is set before going to sea or when entering port during war. It is also set immediately, without further orders, whenever general quarters (GQ) stations are manned. Condition ZEBRA can also be set to localize and control fire and flooding when GQ stations are not manned. When condition ZEBRA is set, all closures (doors, hatches, porthole covers, and valves) marked with a red *Z*, a circled red *Z*, or a red *Z* within a black *D* are secured.

This basic system is modified to allow for special circumstances as follows:

CIRCLE X-RAY and CIRCLE YOKE fittings may be opened without special permission when going to or from GQ stations, when transferring ammunition, or when operating vital systems during GQ. These fittings must be immediately closed once the need to have them open has passed.

CIRCLE ZEBRA fittings may be opened during prolonged periods of GQ, when the condition of readiness is modified by the commanding officer to enable personnel to prepare and distribute battle rations, open limited sanitary facilities, and ventilate battle stations, and it provides access from ready rooms to the flight deck. When open, these fittings must be guarded for immediate closure if necessary.

DOG ZEBRA fittings, secured during condition ZEBRA, are also secured separately during darken ship conditions. These are doors, hatches, or porthole covers that if left open would allow light from inside the ship to be seen outside. The reason for these fittings is obvious in wartime, because allowing lights to show outside at night might help the enemy to detect your ship. DOG ZEBRA fittings are also important in peacetime conditions, because stray lights coming from inside a ship can make it confusing for mariners to see your navigational lights properly, and because stray bright lights can temporarily blind watchstanders so that they cannot see in the darkness.

WILLIAM fittings, marked with a black *W*, are kept open during all material conditions. These fittings are only closed under extraordinary conditions that you will probably never encounter. Examples of WILLIAM fittings are sea-suction valves supplying important engineering equipment and fire pumps.

CIRCLE WILLIAM, marked with a circled black *W*, are normally kept open but must be secured against CBR attack. These are primarily ventilation-system closures that must be secured to prevent the

spread of CBR contaminants (radiation, chemical gases, and germs or viruses).

Remember that it is the responsibility of all hands to maintain the material condition in effect. If it is necessary to break the condition, permission must be obtained (from the OOD or DCC). A closure log is maintained in DCC at all times to show where the existing condition has been broken; the number, type, and classification of fittings involved; the name, rate, and division of the man or woman requesting permission to open or close a fitting; and the date a fitting was opened or closed.

Damage Repairs

Timely and efficient repairs of damage to your ship may someday be necessary to keep her afloat. The difference between survival and sinking for your ship may depend upon how you and your shipmates are able to effect repairs. Damage-control drills will go a long way to preparing you for this eventuality you certainly hope will never come to pass.

In an emergency repair situation, do your best with what you have. If you are calm, alert, and work quickly with the tools you have, you can do much to keep the ship afloat and make her ready for action again.

Any rupture, break, or hole in the ship's outer hull plating, particularly below the waterline, can let seawater in. If flooding is not controlled, the ship will sink. When the underwater hull is pierced, there are only two possible courses of action. The first, obviously, is to plug the holes. The second is to abandon the space or spaces where the penetration has taken place, then establish and maintain flood boundaries within the ship to prevent more extensive flooding.

There are two general methods of temporarily repairing a hole in the hull: put something *in* it or *over* it. In either case, the effect is to reduce the area through which water can enter the ship, or through which water can pass from one compartment to another. Holes may be effectively plugged by pounding in a wooden plug or stuffing it with something larger—such as a kapok life-jacket or a mattress—depending upon the size of the hole. Prefabricated box patches may be placed over a hole with jagged or uneven edges, and a flexible sheet-metal patch may be appropriate for certain types of holes.

Cracks may be sealed using gaskets or some filler material such as caulking or *oakum*.

Shoring (perhaps best described as *bracing*) is often used aboard ship to support ruptured decks, strengthen weakened bulkheads and

decks, build up temporary decks and bulkheads against the sea, support hatches and doors, and provide support for equipment that has broken loose. Knowing the proper time to shore is a problem that cannot be solved by any one set of rules. Sometimes the need for shoring is obvious, as in the case of loose machinery or damaged hatches. But sometimes dangerously weakened supports under guns or machinery may not be noticeable. Although shoring is not always necessary, the best general rule is, "When in doubt, *shore!*"

The basic materials used in shoring are shores, wedges, sholes, and strong-backs. A *shore* is a portable beam. A *wedge* is a block, triangular on the sides and rectangular on the butt end. A *shole* is a flat block that may be placed under the end of a shore for the purpose of distributing pressure. A *strongback* is a bar or beam of wood or metal, often shorter than a shore, which is used to distribute pressure or to serve as an anchor for a patch. Many other pieces of equipment can also be used in connection with shoring.

Fire Prevention and Fighting

Fire is a constant threat aboard ship, and all measures must be taken to prevent it. Fires may start from spontaneous combustion, carelessness, hits by enemy shells, collision, or many other causes. If a fire is not controlled quickly, it could mean loss of the ship.

Whether you are a member of a repair party or not, it is essential that you learn all you can about fires—how they start, how to prevent them, and how to fight them.

Fire Basics

The old adage, "Know thine enemy," is appropriate, for fire is the Sailor's deadly enemy and if you understand the nature of fire, you will greatly improve your chances of keeping it from appearing and defeating it if it does.

The Fire Triangle

The three essential elements for any fire to start and continue burning are *fuel, heat,* and *oxygen.* These three things make up what is called the "fire triangle." Remove any one and you no longer have a triangle. Remove any one of these three elements and the fire will be put out. Think about your backyard barbecue. To start the fire to cook the food, you need charcoal or gas (fuel), a match or lighter (heat), and good ventilation in the barbecue stove (oxygen). If the charcoal gets used up or the gas is turned off, the fuel is removed from the triangle

and your cooking is over. If it rains, your fire will cool down (the heat is removed) and go out. If you place a tight cover over your grill and shut the ventilation openings, your fire will go out as soon as all of the oxygen inside is used up.

Aboard ship, the principles are the same as with your barbecue grill, although probably not as easy to accomplish. It is not always possible, for instance, or even practical, to eliminate fuel. If, however, a flammable liquid fire is being fed by a pipeline, the flow of fuel can be stopped by closing valves in the pipe.

Removing heat is the most common method of extinguishing a fire. The usual cooling method is to use lots of water.

Oxygen can be removed from a shipboard fire by using carbon dioxide (CO_2) to dilute the oxygen content of the air or by smothering the fire with a blanket of foam or sand.

Classes of Fire

Fires can be classified into four different types, identified by the first four letters of the alphabet. Once you know the class of fire you are dealing with, you will be able to fight the fire intelligently and in the most effective manner.

Class Alfa. These fires involve solid substances—wood, cloth, paper—that usually leave an ash. Class Alfa fires are usually characterized by white smoke. Explosives are included in this category. The usual means of extinguishing Class A fires is to use water. In a large fire, the flame is usually knocked down (cooled) with fog (spray), then a solid stream of water is applied to break up the material. Fog is then used for further cooling.

Class Bravo. Class B fires involve flammable liquids, such as oil, gasoline, or paint. These fires usually are characterized by heavy black smoke. For small fires CO_2 is effective. For large fires other agents, such as water and aqueous film-forming foam (AFFF [see below]), must be used. *Never* use a solid stream of water to fight Class B fires. It will only make the fire worse because the water penetrates the fuel's surface, flashes to steam, scatters the fuel, and spreads the fire. Spaces subject to major fuel- or lube-oil spills (firerooms, enginerooms, or fuel-transfer and manifold rooms) are equipped with HALON 1301 (fluorocarbon gas) dispensing systems which, when activated, will knock down a Class B fire.

Class Charlie. Fires in electrical or electronic equipment are classified as Class C. A fire of this type is usually characterized by smoke with a bluish tint along with arcs, sparks, and a distinctive smell you are not likely to forget once you have experienced it. The primary

extinguishing method is to de-energize the equipment, which reduces the fire to Class A or B. The preferred extinguishing agent is CO_2, since it does not leave any residue that may harm or interfere with the efficient operation of the equipment. PKP (a special firefighting chemical powder [see below]) may be used as a last resort, but its corrosiveness will further damage the equipment.

Class Delta. Fires involving combustible metals (for example, magnesium, sodium, or titanium) and any fires that require special handling fall into the category of Class D. Special metals are used for building certain parts of aircraft, missiles, electronic components, and other equipment. An example is the magnesium aircraft parachute flare, which can burn at a temperature above 4000° Fahrenheit. Water used on this type of fire will break down into its natural elements of hydrogen and oxygen, which by themselves are unstable and liable to cause small explosions. You should use low-velocity fog at extreme range and remain upwind of this type of fire and stay behind cover as much as possible. One important safety precaution: the intense light produced by this type of fire can easily cause permanent damage to the eyes, so never look directly at the fire, and wear protective welder's goggles with very dark lenses if they are available.

Fire Prevention

Any fire, however small, is bound to cause damage. For this reason, and because of the potential for disaster, a fire prevented is much preferred to a fire that must be fought.

The first step in fire prevention is to keep things squared away—clean, shipshape, and in their proper places. Keep flammable products (gasoline, oily rags, paint) away from fire-starting articles such as torches and sparking equipment. Don't take open flames near gasoline tanks, and don't bring flammable liquid near a welder's torch.

Make sure firefighting equipment is in the right place and in good condition. If a fire does start, you'll want to have the equipment on hand and ready to go. Even if you may not be able to prevent a fire from starting, you can prevent a little one from getting bigger.

The different classes of fire require different methods of prevention.

To prevent Class A fires, you should never throw lighted tobacco products or matches in trash cans and always be careful of where and how you stow rags and oily, paint-smeared cloth and paper. When welding or burning, maintain a proper fire watch, protect Class A

Table 18.1. Classes of Fire and Extinguishing Agent

Combustible	*Class of Fire*	*Extinguishing Agent*
Woodwork, bedding, clothes, combustible	A	1. Fixed water sprinkling 2. Slid water stream or fog 3. Foam (AFFF) 4. Dry chemical (PKP) 5. CO_2
Explosives, propellants	A	1. Magazine sprinkling 2. Solid water stream or fog 3. Foam (AFFF)
Paints, spirits, flammable liquid stores	B	1. CO_2 (fixed system) 2. Foam (AFFF) 3. Installed sprinkling system 4. High-velocity fog 5. Dry chemical (PKP) 6. CO_2
Gasoline	B	1. Foam (AFFF) 2. CO_2 (fixed) 3. Water sprinkling system 4. Dry chemical (PKP)
Fuel oil, JP-5, diesel oil, kerosene	B	1. Foam (AFFF) 2. Dry chemical (PKP) 3. Water sprinkling or fog 4. CO_2 (fixed system)
Electrical and radio apparatus	C	1. CO_2 2. High-velocity fog. 3. Fog foam or dry chemical (only if CO_2 not available)
Magnesium alloys	D	1. Jettison overboard 2. Wide-angle fog

materials from the open flame and hot droppings, and be sure to inspect the other side of a bulkhead where such "hot work" is taking place.

The danger of Class B fires requires some special methods of prevention. Be aware that in low places in the ship—such as bilges, tanks, and bottoms—there is the danger of the accumulation of flammable gasoline or oil vapors. Don't carry matches, lighters, or keys, and don't wear metal buttons or nylon clothing near gasoline or oil vapors. Use only nonsparking tools in areas where Class B substances have been or are stored. Don't turn on lamps, flashlights, or

electrical equipment that are not certified as spark-proof in an area where gasoline or oil fumes can accumulate.

When working with electrical and electronic equipment, where the possibility exists of a Class C fire, do not paint or splash paint, oil, grease, or solvents on electrical insulation or wires. Report all frayed or worn wires and all sparking contacts, switches, and motors. Report any electrical equipment that is hot, smokes, or makes any unusual noise. In case of fire, secure all electrical equipment in the space. Don't use personal electrical and electronic equipment, such as hotplates, shavers, extension cords, stereos, or radios, unless they have been inspected and authorized by qualified engineering department personnel.

Protect Class D fuels from welding and burning operations. Do not store Class D fuels in areas that are susceptible to intense heat.

Fighting Fires

Despite the most careful precautions, fires can occur. If you discover a fire, report it immediately so that firefighting operations can begin. When reporting a fire, state the type of fire and its location (compartment name and designation), then do what you can to fight it. Always report the fire before taking any action. A delay of even half a minute might result in a minor fire becoming a major one.

After you have reported the fire, do what you can to fight or contain it. The efforts of one person may be enough to contain the fire until the fire party arrives. Use discretion, however. Do what you can consistent with safety. Your becoming a casualty will not help the fire party in its efforts.

To some extent, the procedures for fighting a fire depend on the conditions under which it occurs. Fires that break out during combat, normal steaming, or when a full crew is aboard are handled as battle casualties and the ship goes to GQ. These fires, which may occur in port or at sea, are normally fought by the firefighting party from the repair station in that section of the ship. Aboard larger ships, it may not always be feasible to go to GQ for every fire that occurs, so a nucleus fire party will handle those fires that can be kept isolated and under control. If control is lost, the ship will immediately go to GQ. When a fire occurs in port and only a partial crew is on board, the duty repair party handles it.

While fighting fires, effective communications can be extremely important. A modern means of communicating, using hand-held radios specifically designed for shipboard use, is called damage-control wire-free communications (DC WFCOM). This means of

communication allows personnel at various locations (especially DCC and the scene of the fire) to talk to one another so as to coordinate their efforts and keep the commanding officer informed.

Fires that seem to be out may start again (reflash) from a smoldering fragment or through vapor ignition. The final step in firefighting is the establishment of a reflash watch.

Firefighting Equipment

All firefighting equipment is located in readily accessible locations and inspected frequently to ensure reliability and readiness. At any time, you may be called upon to serve on a repair/fire party, or you may be the only person present to combat a fire. If you don't know how to use the equipment, or what equipment to use, the result could be disastrous.

Firemain

The firemain system is designed to deliver seawater to fireplugs, sprinkler systems, and AFFF stations throughout the ship. The firemain (also called simply "the main") has a secondary function of supplying flushing water and of providing coolant water for auxiliary machinery.

Firemain piping is configured as either a single line, horizontal loop, vertical loop, or composite system depending on the type of ship. On small combatant ships, a single-line system runs fore and aft near the centerline. On many large combatant ships, horizontal-loop systems circle around the ship, providing versatility in case of damage. Some ships have vertical-loop systems winding through their superstructures. Composite systems (a combination of any of the other systems) are used on aircraft carriers because of their size and extensive compartmentation. There are many cross-connection points and cutout valves throughout the system to allow damaged sections of piping to be isolated or "jumped" by attaching hoses at bypass points. Risers (pipes that carry water vertically) and branch lines (horizontal pipes) lead from the main to fireplugs and AFFF systems throughout the ship.

Special attachments called "wye-gates" and "tri-gates" at the fireplugs allow two or three hoses to be attached simultaneously to one fireplug. Reducing fittings allow smaller hoses to be attached to larger fittings when necessary.

Fire Hoses

The standard Navy fire hose has an interior lining of rubber, covered with two cotton or synthetic jackets. It comes in 50-foot lengths with

a female coupling at one end and a male coupling at the other. The female coupling is connected to the fireplug. The male coupling is connected to another length of hose or to a nozzle. When rigging hoses, remember that the male end always points toward the fire and the female end of the hose is rigged in the direction of the fireplug.

Ships generally use 2½-inch hose on the weather decks and 1½-inch hose in the ship's interior. One or more racks at each fireplug are used to stow the fire hose. The hose must be faked on the rack so that it is free-running, with the ends hanging down and the couplings ready for instant use. On large ships, each weather-deck fire station has 100 feet of 2½-inch hose faked on a rack and connected to the plug. Below deck, 200 feet of 1½-inch hose are stowed by each plug, but only two lengths (100 feet) are connected to the plug. On smaller ships, 100 feet of 1½-inch hose are faked on the racks, with 50 feet connected to the plug. A spanner wrench for disassembling the connections is also stowed at each fire station. Spare lengths of hose are rolled and stowed in repair lockers.

Sprinkler Systems

Sprinkler systems are installed in magazines, turrets, ammunition-handling rooms, spaces where flammable materials are stowed, and hangar bays. Water for these systems is piped from the firemain. Some systems are automatically triggered when a compartment reaches a certain temperature, but most are opened manually by control valves.

Aqueous Film-Forming Foam (AFFF)

Aqueous film-forming foam (sometimes referred to as "light water"), a clear, slightly amber-colored liquid, is a concentrated mixture that was developed to combat Class B fires. In solution with water, it floats on the surface of fuels and creates a film (or blanket) that prevents the escape of vapors and thereby smothers the fire.

Permanently rigged AFFF stations are set up in high-risk and vital areas such as hangar bays on aircraft carriers. Usually called "HICAP" stations because of their high-capacity output, these systems do not need to be rigged before activating; they are ready for immediate use when needed. Injection pumps and balance pressure proportioners are used on high-capacity AFFF systems. Individual HICAP stations are able to serve many different firefighting systems. When the station is activated, the pump injects AFFF concentrate into the piping downstream of the firemain control valve after it opens.

The agitation of the water in the piping mixes the AFFF solution. The HICAP system can be activated from numerous local and remote stations, but it must be secured at the HICAP station itself. It is essential that the station be manned by qualified personnel once it is activated.

Portable AFFF systems require some rigging and servicing by the firefighting party. The male end of the hose line feeding seawater to the eductor (see below) is threaded into the female end of the portable eductor. A pickup tube (with a special ball-check valve that ensures one-way flow) must be inserted into a canister of AFFF. Seawater passing through the eductor causes a suction in the pickup tube that draws AFFF concentrate from the five-gallon container. The eductor mixes the AFFF concentrate and seawater and delivers them to a 95-gallon-per-minute (gpm) variable-pattern AFFF nozzle which is used to direct and distribute the solution.

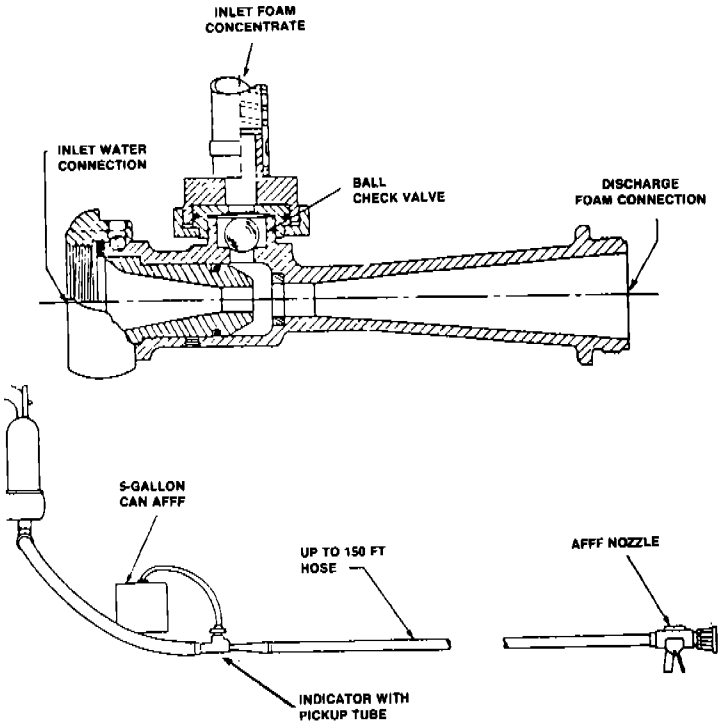


Figure 18.6. An in-line eductor is used to mix AFFF concentrate and seawater.

To maintain the correct AFFF concentrate-to-water ratio, firemain pressure should be maintained. A pressure decrease due to friction in the hose could reduce pressure sufficiently to cause an improper AFFF concentrate and water mixture. Limiting the lengths of fire hose to three (for a total of 150 feet) and a rise of no more than one deck between the eductor discharge and the AFFF nozzle will maintain the needed pressure. Continuous use requires approximately five gallons per minute of AFFF concentrate. Fresh five-gallon canisters of the concentrate must be provided as necessary to maintain the flow of AFFF.

Portable Extinguishers

There are two types of portable extinguishers used in the Navy: *carbon dioxide* (commonly called CO_2) and *dry chemical* (usually called PKP).

CO_2 extinguishers are used mainly for electrical (Class C) fires, but they are also effective on small Class A and B fires, such as an office trashcan or small amounts of oil, gasoline, and paint. Because CO_2 is heavier than air, it forms a smothering blanket over the fire. The extinguisher's effective range is four to six feet from the end of the horn.

To use the extinguisher, remove the locking pin from the valve, grasp the insulated handle of the horn with one hand, and squeeze the grip with the other. If you are in the open, approach the fire from the

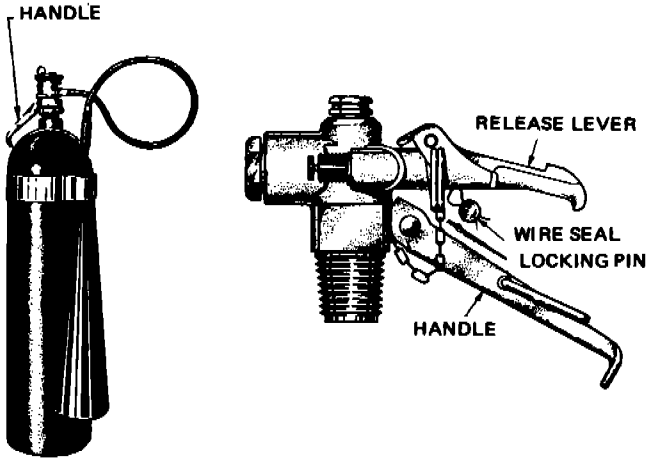


Figure 18.7. The portable CO_2 extinguisher with detail of the handle, release lever, and locking pin.

windward side (wind at your back). This extinguisher is quick to use, leaves no residue, and is not poisonous. But remember that CO_2 is capable not only of smothering fires but human beings as well. Use it sparingly in confined spaces. Also be aware that when released from the cylinder it expands rapidly to 450 times its stored volume, which causes the gas temperature to drop to minus 110° Fahrenheit. Contact with the skin can cause painful blisters.

Dry-chemical extinguishers are primarily used against Class B fires. The chemical used is purple potassium bicarbonate (similar to baking soda), also called "purple K powder" or "PKP."

PKP is nontoxic and four times as powerful as CO_2. It is also effective on Class C fires, but should not be used if CO_2 is available because it leaves a residue that may be harmful to the electronic components. PKP should not be used on internal fires in gas turbines or jet engines except in dire emergency for the same reason.

The dry-chemical extinguisher is available in two sizes. The K-20 contains 18 pounds of PKP, the K-30 contains 27 pounds of PKP, and both use CO_2 (from a cartridge) as a propellant. The extinguisher shell is not pressurized until it is to be used. Handling the extinguisher is simple. Pull the locking pin from the seal-cutter assembly, tilting the bottle away from you and others for safety, and strike the puncture lever to cut the gas-cartridge seal. The extinguisher is then charged and ready for use. Discharge the chemical in short bursts by squeezing the grip on the nozzle and sweeping the fire from side to side. Advance on the fire only if safe (a range of 19 to 21 feet is ideal). When you are finished, invert the cylinder, squeeze the discharge lever, and tap the nozzle on the deck. This releases all pressure and clears the hose and nozzle of powder.

Dry chemical is an excellent firefighting agent, but its effects are temporary. It has no cooling effect and provides no protection against reflash. Therefore it should be backed up by AFFF. In confined spaces, PKP should be used sparingly. Prolonged discharge of the chemical reduces visibility and makes breathing difficult.

There are often two types of fixed fire-extinguisher installations in areas such as machinery spaces and hangar decks. Fixed CO_2 extinguishers are a dependable, ready means of flooding spaces that are more-than-ordinary fire hazards. Cylinders have a 50-pound capacity and are mounted either singly or in banks of two or more. An installed CO_2 extinguisher is used as a flooding system for spaces not continually occupied by personnel, such as paint lockers.

An AFFF/PKP combination is an extremely effective means of controlling a Class B fire. The dry chemical is used to knock down

the fire, and the AFFF blanket prevents a reflash. Aircraft carriers have a portable AFFF/PKP system known as a twin-agent unit (TAU) mounted either on its own carriage or on the back of an aircraft tractor.

Pumps

The P-100 is a portable diesel engine-powered pump designed to pump 100 gallons per minute (gpm). It can be used to fight fires or to dewater spaces, depending upon how it is rigged. It has a 3-inch inlet, attached to one or more lengths of hard-rubber suction hose, on the end of which is a foot valve and strainer assembly. The discharge is a 2½-inch gate valve with hose threads that can be attached to either a standard wye-gate (two 1½-inch hose connections), a special tri-gate (one 2½-inch and two 1½-inch hose connections), or a 2½-inch hose, depending on whether the pump is being used for firefighting or dewatering.

Like any other internal combustion engine, the P-100 produces carbon monoxide. When it is used below decks, the exhaust must be led outside the ship. Lengths of 2-inch hard-rubber hose are available for this purpose. This pump should never be run in a space containing explosive vapors.

In firefighting, a vast amount of water is often discharged into the ship. For instance, a 2½-inch hose with a pressure of 100 pounds per square inch (psi) pumps nearly a ton of water per minute. Obviously, this water must be removed or the ship's stability will be greatly impaired.

The P-100 pump can be used for dewatering by itself or with other equipment to increase the pumping rate dramatically. A pumping rate of 100 gpm is not always sufficient to dewater spaces. The dewatering rate of a single pump can be doubled with a jet pump called an eductor. The P-100 draws a suction from the space being dewatered and discharges it to an eductor in the same space. Since the eductor is virtually 100 percent efficient, the discharge from the eductor will be double the gpm of the P-100. Eductors are also used when the liquid to be pumped (gasoline or other flammables) cannot be handled by the pump itself. This practice eliminates the chance of damaging the pump or igniting the liquid. Eductors are also often employed alone, using the ship's firemain as a source of water pressure.

The electric submersible pump is the most versatile and easiest to rig of all dewatering pumps. It is powered by 440 volts of electricity and its pumping capacity depends upon the maximum height of the

discharge hose. With the discharge hose at a height of 50 feet, the pump discharges 200 gpm, but when it is at 70 feet, it is capable of only 140 gpm.

When a large height is unavoidable, it is possible to rig two pumps in tandem with a length of 2½-inch hose between them. The lower pump is activated first and primes the upper pump, which is then activated. Since the water being pumped is also cooling the pumps, the upper one must be carefully monitored to prevent overheating. Overheating of the pump causes its internal seals to deteriorate and leak, resulting in an electrical short circuit that severely damages the pump.

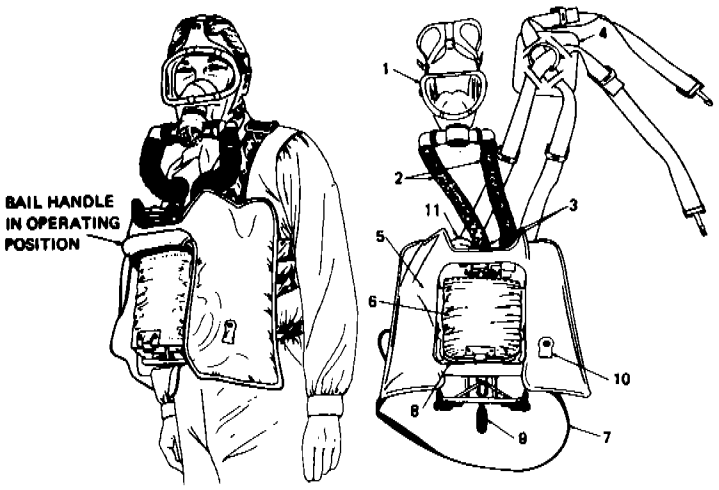
Protective Clothing and Equipment

Any clothing that covers your skin will protect it from flash burns and other short-duration flames. In situations where there is a likelihood of fire or explosion, keep covered as much as possible, and protect your eyes with antiflash goggles.

If your clothes catch fire, don't run. This fans the flames. Lie down and roll up in a blanket, coat, or anything that will smother the flames. If nothing is available, roll over slowly, beating out the flames with your hands. If another person's clothes catch fire, throw the person down and cover him or her (except for the head) with a blanket or coat.

Aluminum-coated proximity suits are designed to protect the wearer from the radiant heat of fire. The suits offer only short-term protection. When worn by pilot-rescue personnel, the suits are continuously sprayed down to prevent overheating and should never make contact with actual flames. Proximity suits are used for open-air fires only and should never be used to combat fires inside the ship.

One piece of support equipment used by firefighting parties that is often invaluable is the *oxygen-breathing apparatus,* more often called simply an OBA. The replenishable canisters used with the OBA provide a supply of oxygen that gives the wearer the ability to go into compartments that have been robbed of adequate oxygen by a fire or that contain harmful gases, smoke, vapors, or dust. The oxygen is supplied by chemicals that purify exhaled air. The wearer's breath is circulated through the canister of chemicals, which react with CO_2 and the moisture in the wearer's breath to produce oxygen. The process continues until the oxygen-producing capacity of the chemicals is used up. When the face-piece of an OBA needs cleaning, use only soap and water, never alcohol. Never use grease or oil on any part of the OBA.



1. FACEPIECE
2. BREATHING TUBES
3. BREATHING TUBE COUPLINGS
4. BODY HARNESS AND PAD
5. BREATHING BAG
6. BREASTPLATE
7. WAIST STRAP
8. BAIL ASSEMBLY HANDLE (STANDBY POSITION)
9. CANISTER RELEASE STRAP
10. PRESSURE RELIEF VALVE AND PULL TAB
11. TIMER

Figure 18.8. The OBA allows you to enter a compartment that has been robbed of adequate oxygen by a fire.

Never enter a danger area until you are sure the apparatus is working correctly. OBAs are equipped with a timer that will tell you how much time has elapsed since you started your canister. Start the timer every time you start a new canister; when the timer goes off, or when it becomes difficult to exhale, return to fresh air.

For all their value, OBAs can be dangerous if mishandled. A used canister is very hot. Wear fire-resistant gloves or equivalent protection for your hands whenever you must handle a recently expended canister. Also be aware that the chemical in canisters is very caustic to the skin. If the chemical is accidentally spilled on deck, clean it up immediately using a nonflammable metal implement for a scoop. Oil, gasoline, or similar substances that come in contact with the chemicals can cause an explosion. Be sure you drop the used canister on a dry deck. Also be sure there is no chance for it to drop through or off a grating and into the bilges.

Expended canisters are normally discarded as hazardous waste. Never throw a canister overboard without getting permission from

the OOD, and never throw a canister overboard if there is an oil slick on the water, or if the ship is in port. Also, do not hold your face or any part of your body over a canister opening.

Another important piece of support equipment is the *Scott Air-Pak 4.5*. Similar to the OBA, it also is a self-contained system, providing oxygen to the wearer by means of a self-contained air source. The face piece comes in three colors—green for small, black for large, and red for extra large. The face-piece contains a voice amplifier powered by a 9-volt battery.

Another alternative to the OBA, which may be used for entering smoke-filled compartments to rescue crewmembers, is the *air-line mask*. Since it produces no oxygen of its own, it should never be used when actually fighting a fire. The mask is a demand-flow air-line respirator with a speaking diaphragm, monocular lens with adjustable head harness, breathing tube, and belt-mounted demand regulator with quick-disconnect fittings. The mask comes with a 25-foot hose and quick-disconnect fittings. It is normally used with compressed air cylinders, but when these are not available, low-pressure ship's-service air may be used as an alternative, provided it is reduced to the proper operating pressure. Never use an oxygen cylinder with this

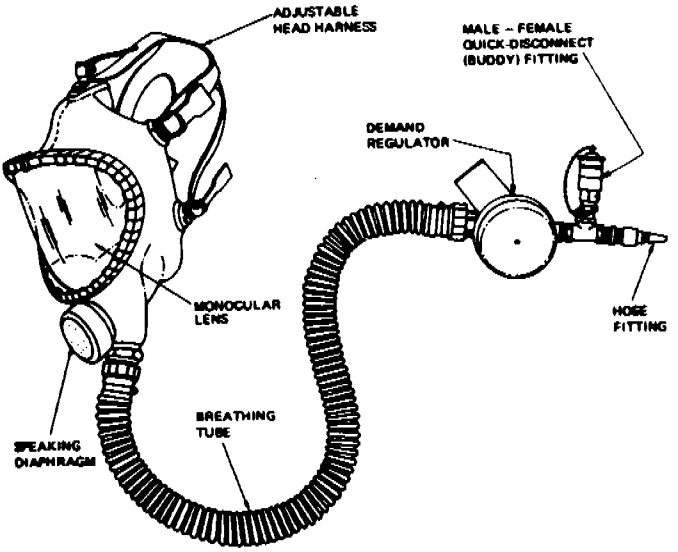


Figure 18.9. The air-line mask is normally connected to compressed air cylinders but may be connected to the ship's low-pressure ships'-service air system.

equipment. Oil, grease, or oily water in the apparatus might combine with the oxygen and explode. Before entering a space filled with toxic gases or smoke, check the mask to be sure it is working properly, then take a breath to determine whether there is sufficient airflow.

Tending lines are 50-foot lengths of nylon-covered steel wire used with the OBA or the air-line mask, with snap hooks at each end of the line. Tending lines are used as a precautionary measure in rescuing a fire investigator or firefighter. Rescuers equipped with OBAs follow the lines to the victim; they do not drag the person out by the lines except in cases when no other method of rescue is possible. Never attach a tending line to your waist. If, in emergency, you must be pulled from a space, a line attached at your waist might interfere with your breathing or cause internal injuries. OBAs are equipped with a D ring on the back of the harness assembly so that the tending line can be easily fastened.

The tending line serves another useful function in that it can be used to communicate. In order to accomplish this, a standard set of signals is used throughout the Navy (see Table 18.2). One way to remember the line signal is to think of the acronym OATH. *O* (okay), *A* (advance), *T* (take up slack), *H* (help).

The *emergency-escape breathing device* (EEBD), a fire-escape mask, consists of a head covering with a transparent face screen that can be donned quickly. Each EEBD carries a canister, which functions the same way as an OBA canister and provides the wearer with about 15 minutes' breathing time (depending upon the physical exertion involved). This should enable the wearer to escape from any space to the ship's topside. It is especially designed to protect against smoke inhalation.

Table 18.2. Tending Line Signals

	Pulls	*Meaning*
Tender to wearer	1	Are you OK?
	2	Do you want to advance?
	3	Should I take up slack?
	4	Do you need help?
Wearer to tender	1	I am OK.
	2	I am going to advance.
	3	I want you to take up slack.
	4	I need help.

Personnel working in engineering spaces wear *Supplemental Emergency Egress Devices (SEED)* on their belts for easy access. Unlike the EEBD, the SEED does not provide protection for the eyes and nose, and it has a short operational time. It is meant only as a supplementary device, used temporarily to allow a watchstander to get to an EEBD.

All closed or poorly ventilated compartments (particularly those in which a fire has just occurred) are dangerous because the air in them may lack oxygen or contain toxic gases. Three steps should be taken as a matter of routine to test for combustible or toxic gases in confined spaces. The first step should be to test for oxygen content; the second for combustible vapors or gases; and the third for toxic substances. There are several types of atmosphere-testing indicators available for use by firefighting personnel.

Combustible-gas indicators (explosimeters) are used to detect the level of explosivity of various flammable gases and vapors. Several different types of indicators are available, but all operate on the same principles. Operating instructions are attached to the inside of the case cover. This type of indicator can quickly, safely, and accurately detect all combustible gases or vapors associated with fuel oil, gasoline, alcohol, acetone vapors, illuminating gas, fuel gas, hydrogen, and acetylene in mixtures with air or oxygen. The indicator is sensitive to even small quantities of these substances. Although it does not actually identify specific combustibles, it indicates what their explosive level is. These instruments are equipped with flame arresters to prevent flashbacks.

Intended solely for the detection of oxygen deficiency in the atmosphere of a space, the oxygen indicator is designed to give a continuous reading of oxygen concentration from 0 to 25 percent. The oxygen indicator must be calibrated before each use.

The sensing head of the indicator should be introduced into every part of the compartment, from top to bottom. If a deficiency of less than 20 percent oxygen exists, the compartment should be fully ventilated and retested. Before using the oxygen indicator, you should become very familiar with the instructions for its operation.

The *Draeger toxic-gas detector* is a hand-operated, bellows-type aspirator pump into which the appropriate detector tube is inserted. The three gases commonly tested for are carbon monoxide, carbon dioxide (CO_2), and hydrogen sulfide.

After a fire has been extinguished, it is usually necessary to desmoke the affected compartment(s). This is done with natural or

forced ventilation. In clearing the smoke out, several cautions should be noted:

Be sure the fire is really out.
Investigate the ventilation systems in the affected areas to make sure they are free of burning or smoldering materials.
Have fire parties and equipment standing by the blower and controller of the ventilation systems.
Obtain permission from DCC (or the engineer) to open ventilation-system closures and start the blowers.

Portable ventilating—blowers, electric or hydraulic (water operated) or pneumatic (air operated)—can be employed for de-smoking, although they are not as efficient or convenient as permanent ventilating systems. When explosive vapors or fumes are present, it may be dangerous to use the ship's permanently installed ventilation systems. Under these circumstances, use only portable blowers.

Firefighting Parties

Every shipboard firefighting party consists of two hose teams known as the attack party. The no. 1 hose team is the attacking unit, and the no. 2 team is the backup.

The *scene leader* is in charge of the firefighting party. The scene leader's first duty is to get to the fire quickly, investigate the situation, determine the nature of the fire, decide what type of equipment should be used, and inform DCC. Later developments may require different or additional equipment, but the scene leader must decide what equipment is to be used first.

The *team leader* for each hose team directs the action of the nozzlemen and the other members of her or his team.

Nozzlemen man the nozzles of the hoses wearing complete battle dress plus gloves, flash hoods, an OBA, and a miner's headlamp. Besides controlling the "business end" of the hose, nozzlemen help the scene leader investigate the fire when OBAs are needed to enter a compartment.

Hosemen lead out the hose from the fireplug, remove kinks and sharp bends, and tend it while it is being used. When fighting the fire, they too wear OBAs.

Investigators make continuous tours of inspection of those spaces adjoining the fire, looking for further damage, taking soundings (checking fluid levels in lower spaces), and leading personnel trapped

in smoke-filled compartments to safety. In order to accomplish the latter, these team members also wear OBAs.

To ensure that those personnel wearing OBAs have a safety backup, they are assisted by team members called *OBA tenders.* They guard tending lines (when used) and keep spare OBA canisters available.

Plugmen stand by to operate fireplug valves when ordered. They also rig and stand by jumper hoses (used to bypass damage) when necessary.

Accessmen clear routes to gain access to the fire by opening doors, hatches, scuttles, and other closures. They carry equipment to open jammed fittings and locked doors.

AFFF supplymen prepare foam-generating equipment and keep the system supplied with AFFF.

CO_2 supplymen carry CO_2 and PKP extinguishers.

The *closure detail* secures all doors, hatches, and openings around the area to isolate the fire. All ventilation closures and fans in the smoke and heat area are secured by this detail, which also establishes secondary fire boundaries by cooling down nearby areas.

The *electrician* de-energizes and re-energizes electrical circuits in the fire area and rigs power cables for portable lights, tools, and blowers.

The *hospital corpsman* provides on-scene first aid and is responsible for supervising the movement of seriously injured persons to sick bay for treatment.

The *phone talker* plugs into the nearest JZ circuit to establish and maintain communication with DCC, either directly or through the local repair party.

The *messenger* delivers messages between the scene leader and the repair party leader.

Other personnel and equipment assigned to a firefighting party may include *foam-equipment operators,* additional hosemen, *proximity suitmen* (who wear special protective clothing that will allow them to get much closer to a fire than can someone with only normal protective clothing), a *portable (oxyacetylene) cutting outfit* (PCO) operator, the *de-watering/de-smoking equipment team,* and an *atmospheric test equipment operator* (who uses explosimeters, oxygen indicators, toxic-gas detectors, and other pieces of equipment to determine what dangers exist at the scene of the fire).

19 Seamanship

As a Sailor, whether you eventually strike for boatswain's mate or personnelman, there are certain basic skills of seamanship you will need to know or at least be familiar with. Few Sailors can say they've never handled a line or needed to tie a knot. All ships, whether they are patrol craft or aircraft carriers, use mooring lines to secure themselves to piers, anchors to hold them in place where there are no piers, special rigs to transfer supplies during an UNREP, and many other forms of equipment and skills that are unique but essential ships and boats.

Marlinespike Seamanship

The art of working with line or rope is called "marlinespike seamanship" or, sometimes, "marlinespiking." The name comes from a special tool used in working with rope which is called a "marlinespike."

It is important to learn the special terminology associated with marlinespike seamanship, primarily because you want to avoid confusion. But there is a good secondary reason as well. There are certain measures of professionalism in the Navy that have no official status and have nothing to do with getting you promoted, but are used to size you up as a true Sailor rather than a landlubber. If you want to be recognized as a true Navy professional—to earn the respect of those more experienced than you—you should make an effort to think, act, and speak like a Sailor. This means you should use 24-hour time, call a deck a deck (and not a floor), and know the difference between rope and line.

In the Navy, the term *rope* refers to both fiber and wire. Fiber rope includes those made of such natural materials as manila and hemp and those made of synthetic materials such as nylon. Here is the tricky part. Fiber rope is called "rope" only as long as it is still in its original coil. Once a piece has been cut to be used for some purpose (such as mooring or heaving), it is then called a "line." If you want to be considered a novice, call a line a rope. Rope made of wire (or a

combination of wire and fiber) is usually called "wire rope" or simply "wire" (even if it has been cut from its original coil and is being used for some specific purpose). To make this just a little bit more confusing, there are some exceptions. The life*lines* on ships are nearly always made of wire, for example. You are probably pretty safe if you just forget about the word "rope" and use the words "line" and "wire."

What you would probably call a "loop" in a line is called a *bight* in the Navy. "Looping" a line around an object is called *taking a turn* or *taking a round turn.* Lines do not "break" in the Navy, they *part.* The free end of a length of line is called the *bitter end.*

The simplest construction of a fiber line is to start with small fibers, which are twisted until they form larger pieces called "yarns." Then the yarns are twisted in the opposite direction to form "strands," after which they are twisted in the original direction to become a line. The direction of this final twisting determines the "lay" of the line. Line can be either three- or four-strand, though three-strand is most common in the Navy. Nearly all three-strand line used in Navy ships is what we call "right-laid," meaning that the strands are twisted to the right. It is important to know this because you should always try to coil a line in the direction of its lay. For example, right-laid line should always be coiled in right-hand (clockwise) turns. This will prevent kinking and extend the life of the line.

Lines can also be formed by a different process called "braiding." Braided lines have certain advantages over twisted ones. They will not kink and will not flex open to admit dirt or abrasives. The construction of some, however, makes it impossible to inspect the inner yarns for damage. The more common braided lines are hollow braided, stuffer braided, solid braided, and double braided.

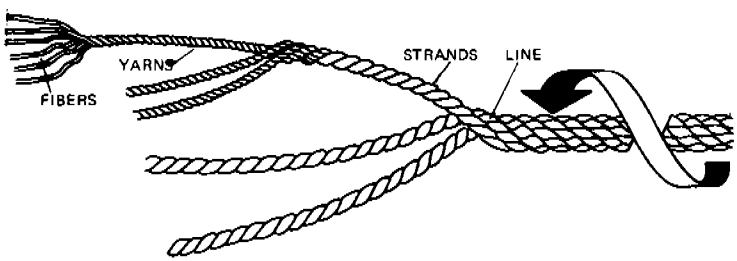


Figure 19.1. The components of a line.

Fiber Lines

Synthetic- and natural-fiber lines have certain advantages and disadvantages over one another. The common synthetic fibers—nylon, polyester (Dacron), polypropylene, and polyethylene (in descending order of strength)—ranging in size from 5/8 inch to 12 inches in circumference, are generally stronger than natural fibers and not subject to rot. Nylon is over twice as strong as manila (the most common natural fiber), lasts five times as long, and will stand seven times the shock load. Dacron gets stronger when wet, and polypropylene is so light it floats, both of which are obvious advantages in a marine environment. The biggest disadvantages of synthetic line when compared to natural-fiber line is that synthetics stretch under heavy loads and it is more difficult to tell when they are going to part. Another disadvantage of synthetic line is that it does not hold knots as well as natural fibers. Some knots that are good for securing natural fibers, such as the square knot, are not adequate for synthetic. The bowline is one knot known to offer reasonable security when bending together or securing synthetic line.

Fiber lines are identified by their circumference and type; for example, "two-inch manila" or "three-inch nylon." Lines larger in circumference than five inches are called *hawsers*. Line that is less than one inch in circumference is usually called *small stuff*.

Synthetic Lines

Before you use new three-strand synthetic, it should be faked down on deck and allowed to relax for 24 hours. The period can be shortened to about two hours by hosing down the line with fresh water.

When it is wet, synthetic line shrinks slightly but does not swell or stiffen. When tension is applied to the line, water squeezes out; under working loads, it appears as vapor.

Oil and grease do not cause synthetics to deteriorate, but they make them slippery. When this happens, the line should be scrubbed down. Spots may be removed by cleaning the line with light oils such as kerosene or diesel oil.

Sailors who work with natural-fiber line soon learn how to judge tension by the sound the line makes. Unfortunately, although synthetic line under heavy strain thins down considerably, it gives no audible indication of stress—even when it is about to part. For this reason, a *tattletale* line should be attached to synthetic line when it is subjected to loads that may exceed its safe working load. A tattletale line is a piece of smaller line that is attached to a synthetic line at two carefully measured points so that it droops down. As the synthetic

line stretches, the droop in the tattletale will get less and less. When the tattletale has become taut and is lying parallel to the synthetic line, you will know that the line is in danger of parting.

Natural-fiber Lines

Because of its tendency to retain water and to rot, special care and handling are required when using natural-fiber lines.

Coils of line should always be stowed on shelves or platforms clear of the deck. They should never be covered in such a way that may prevent the evaporation of moisture.

Whenever possible, a wet line should be dried before stowing. If line must be stowed wet, it should be laid up on gratings in long fakes or suspended in some other way so that it will dry as quickly as possible. It should never be covered until dry.

To prevent cutting or breaking of the outer fibers, keep lines from rubbing against other objects whenever possible, particularly sharp or jagged ones. Avoid dragging line over ground where it can pick up dirt and other particles; these can work their way into the line and weaken the line by cutting the inner strands.

Under normal working conditions, the strength of line exposed to the elements deteriorates about 30 percent in two years. Lines should be inspected frequently for deterioration. Open the lay by twisting in the opposite direction and inspect the fibers. A white powdery residue indicates internal wear. After particularly heavy use, inspect the inside threads to see if all or a portion of the fibers are broken.

Wire Rope

The construction of wire rope is similar to that of fiber lines. Wire rope consists of individual wires made of steel or other metal, in various sizes, laid together to form strands. The number of wires in a strand varies according to the purpose for which the rope is intended. A number of strands are laid together to form the wire rope itself. Wire rope is designated by the number of strands per rope and the number of wires per strand. Thus, a 6 by 19 rope has 6 strands with a total of 19 wires per strand.

Wire rope made up of a large number of small wires is flexible, but small wires break so easily that the rope is not resistant to external abrasion. Wire rope made up of a smaller number of larger wires is more resistant to abrasion, but less flexible.

Never pull a kink out of a wire rope by putting strain on either end. As soon as you notice a kink, uncross the ends by pushing them apart; this reverses the process that started the kink. Then turn the bent por-

tion over, place it on your knee or some firm object, and push down until the kink starts to straighten out somewhat. Then lay it on a flat surface and pound it smooth with a wooden mallet.

Damage to a wire rope is indicated by the presence of what are called "fishhooks." These occur when individual wires break and bend back. If several occur near each other or along the rope's length, it is an indication that the wire rope is less reliable and may require replacement. Because of these "fishhooks," always wear gloves when handling wire.

You should inspect wire rope frequently, checking for fishhooks, kinks, and worn spots. Worn spots show up as shiny flattened surfaces.

Wire rope should never be stored in places where acid is or has been kept. Prior to storage, wire rope should be cleaned and lubricated.

Working with Line

Certain skills and practices, some of them simple and others more complicated, must be learned in order to work with line. The experts at working with line are the boatswain's mates, but every Sailor should be familiar with a number of these skills.

Stowing Line for Ready Use

Once a line has been removed from the coil, it may be prepared for storage or ready use, either by winding on a reel or in one of the following ways.

Coiling down. Lay the line down in circles, roughly one on top of the other. Right-laid line is always coiled down right-handed, or clockwise. When a line has been coiled down, the end that went down last on top is ready to run off. If you try to walk away with the bottom end, the line will foul up. If for some reason the bottom end must go out first, turn the entire coil upside down to free it for running.

Faking down. The line is laid down as in coiling down, except that it is laid out in long, flat bights, one alongside of the other, instead of in a round coil. A faked down line runs more easily than a coiled line.

Flemishing down. Coil the line down first, then wind it tight from the bottom end, counterclockwise, so that it forms a close mat. This method of stowing a line not only keeps it ready for use, it looks good.

Securing Ends

Never leave the end of a line without what is called a *whipping*. This can be a piece of small stuff tied to the end of the line or a piece of tape wrapped around it to prevent the end of the line from unravel-

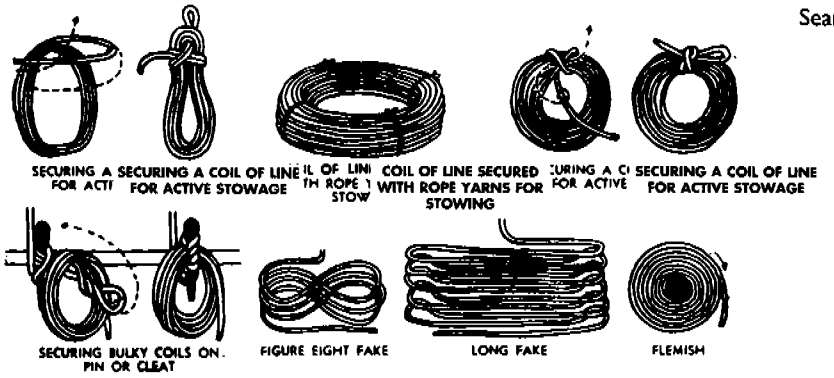


Figure 19.2. Different ways of stowing line.

ing. A good method to use for nylon line is to wrap a piece of tape around the end, leaving the tufted end of the strands exposed. You should then singe the exposed strands, causing them to melt together.

Joining Lines Together

The most obvious method of joining lines together is to tie them with a knot. Other methods are also used for specific purposes because of the advantages they provide.

Knots, bends, and hitches. When you tie two lines together, you have formed a *bend.* When you tie a piece of line to some other object, it is called a *hitch.* To a seaman, a *knot* in a line usually means the line is tied to itself. In many cases, these functions may overlap, so these terms are not absolute. One guiding principle is that knots are usually meant to be permanent and are therefore more difficult to untie than are bends and hitches.

There are big, thick books describing the many varieties of knots, bends, and hitches, but if you are comfortable with just a few, you will be able to take care of virtually any common situation. If you learn no others, be sure that you can at least tie a *square knot* (also called a *reef knot*), a *bowline,* a bowline-on-a-bight, and a clove hitch. Others will prove useful in special situations, such as the *figure eight* (used to put a temporary end to a line), *catspaw* (secures a cargo sling to a hook), *timber hitch* (good for lifting or securing logs, planks, and other long, rough-surfaced objects), and *carrick bend* (used to bend two hawsers together). The more knots, bends, and hitches you know, the better you will be able to use line to your advantage in a wide variety of situations.

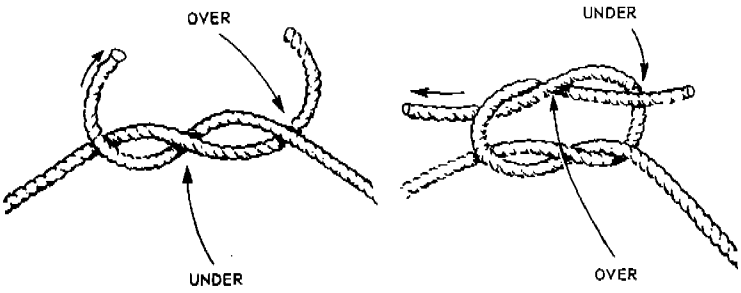


Figure 19.3. Tying the square knot.

Ornamental knots are used to give your ship a smart nautical appearance and to promote safety and habitability. Just as with practical knots, bends, and hitches, there are virtual encyclopedias of ornamental work. *Turk's heads, fox and geese,* and *sennits* are just a few of the many forms of ornamental knots you will more than likely encounter during your time in the Navy.

Seizings. Sometimes it is useful to secure two lines together side by side. This is accomplished by using a variety of what are called *seizings.*

Splices. When lines are to be joined end to end, they are *spliced.* A line can also be bent on itself and spliced to form a permanent loop on the end of the line. If properly done, splicing does not weaken the line. A splice between two lines will run over a sheave or other object much more easily than a knot.

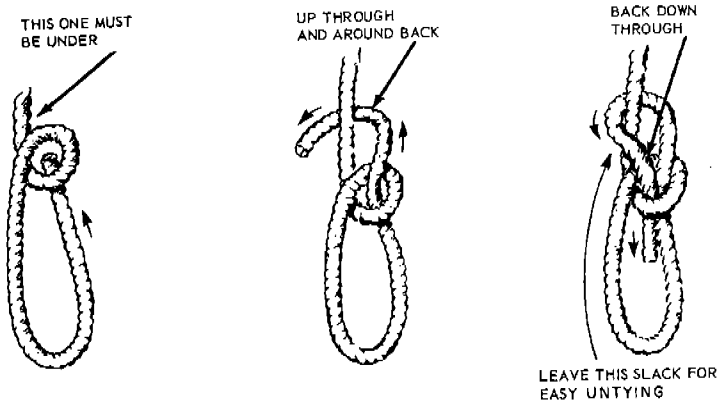


Figure 19.4. Tying a bowline.

Working with Wire Rope

The greater strength of wire rope as compared to fiber line is offset somewhat by its lesser flexibility and its tendency to rust if conditions are not right. Wire rope that is frequently exposed to weather or hard use requires some extra measures of protection to prolong its service life.

Worming. The lay of the rope is followed between the strands with tarred small stuff. This keeps moisture from penetrating the interior of the rope and fills out the rope, giving it a smooth surface ready for parceling and serving.

Parceling. This is accomplished by wrapping the rope spirally with long narrow strips of canvas, following the lay of the rope and overlapping turns to shed moisture.

Serving. The final step in preserving wire rope is accomplished by wrapping small stuff snugly over the parceling, pulling each turn as taut as possible so that the whole forms a stiff protecting cover for the rope. A tool called a *serving mallet* is used for passing the turns in serving, and each turn is pulled taut by the leverage of the handle. Remember this poetic rule:

Worm and parcel with the lay,
Turn and serve the other way.

Mooring

One very common and important use of lines in the Navy is mooring. Mooring is defined as securing a ship to a pier or to a mooring buoy, or by anchoring. In order to maximize pier space, Navy ships are also frequently moored to other ships, creating a *nest* of ships alongside a pier. In order to properly moor a ship to a pier, certain standardized procedures make the operation efficient and a knowledge of the appropriate terminology is essential. Standard commands, the deck fittings, and the lines themselves all are referred to in ways that must be understood by Sailors in order to take part in the operation or to stand watches properly once a ship is moored.

Mooring Equipment

In order to moor a ship properly, you will need to be able to identify certain items of equipment that are unique to ships. To begin with, a mooring line will do no good without the necessary fittings on the ship and on the pier to which the mooring lines are secured. A *cleat*

consists of a pair of projecting horns for *belaying* (securing) a line. Bitts are cylindrical shapes of cast iron or steel arranged in pairs on the ship's deck and/or on the pier which are also used to belay lines. A *bollard* is a heavy cylindrical object with a bulbous top and a horn that is found on piers but not on ships. The eye or bight of a mooring line can be passed over it and, because of its design, the line will not slip off. A *chock* is different from the other fittings so far mentioned because lines are not secured to it but instead are passed through. Chocks come in three varieties—open, closed, and roller—and are used to feed lines in the direction you want, thereby increasing efficiency. A typical mooring configuration would have lines running from bitts aboard ship, through chocks, to a bollard (or a cleat or another set of bitts) on the pier.

To protect the sides of your ship from rubbing or banging against the pier, *fenders* and *camels* are used. Fenders are shock absorbers of various types (such as rubber shapes or clusters of line) suspended from the ship or pier to serve as a cushion between them. Camels serve the same purpose, but instead of being suspended from the deck, they float in the water. Besides protecting the ship and pier from contacting each other, camels are used to keep aircraft carriers further away from the pier because of their overhanging elevators. If you moored an aircraft carrier to a pier without camels to hold it off, the elevators would, in many instances, lower right onto the pier or

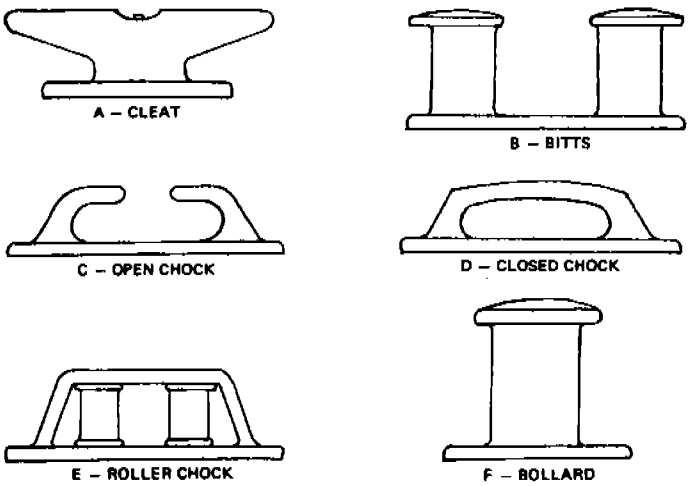


Figure 19.5. Cleats, bitts, and chocks are used on ships to secure lines. Bollards are found on piers or wharves.

dangerously close to it. To prevent rats from coming aboard your ship, using your mooring lines as convenient pathways, circular metal discs called (appropriately enough) *rat guards* are lashed to the mooring lines.

During the mooring process, a light line called a *messenger* is first sent over. Then, with the mooring line itself attached, it is hauled in. To help get the messenger across from the ship to the pier, a heaving line, bolo, or line-throwing gun is used, depending upon the distance of the ship from the pier. A heaving line is a light line with a weight, called a *monkey fist,* on one end; a bolo line is a nylon line with a padded lead weight or a monkey fist on it that is designed for throwing a greater distance by first twirling it in a circle to build up momentum before letting it go. A line-throwing gun is a modified shotgun that can fire a special projectile with a line attached. It will reach farther than a heaving line or bolo but, for obvious reasons, is dangerous to use, particularly when many people are standing on the pier.

Mooring Lines

Mooring lines are referred to by both numbers and by names. They are numbered starting with the forward-most one (number 1) and continuing aft in sequence. Mooring lines are named by a combination of their location, their use, and the direction in which they tend as they leave the ship.

Once a ship is moored to a pier or to another ship, it is important to prevent the ship from moving along (laterally) and to keep it from moving up and down (parallel to) the pier. Mooring lines are designed to prevent these two things. Lines that prevent ships from drifting away from the pier—in other words, that control lateral movement—are rigged perpendicular, or nearly so, to the pier and are called *breast lines*. Lines that prevent or minimize forward and aft movement—in other words, motion parallel to the pier—are rigged nearly parallel to the pier and are called *spring lines*.

The mooring configuration will differ depending upon the size of the vessel being moored and the surrounding conditions (tides, currents, weather), but a standard six-line moor will illustrate most of what you need to know about mooring a ship to a pier. The first line (farthest forward) is called the *bow line* and runs through the *bullnose* (chock on the very front of the ship) and then to the pier. The next line aft is numbered "2" and is called the *after bow spring*. This name is derived from the fact that it *tends* (goes) aft, is located in the forward half of the ship (hence the word "bow"), and is a spring line (in this case it prevents the forward motion of the ship). Moving aft

along the ship's main deck, the next line you would encounter would be the number three line, and it is called the *forward bow spring*. This, too, is a spring line because it keeps the ship from moving backward along the pier. The other parts of its name tell you it is located on the forward part of the ship (bow) and that it tends forward. The next two lines aft would be numbers four and five and they would be called the *after quarter spring* and the *forward quarter spring*, respectively. These lines are also spring lines and function the same as their counterparts on the bow. Because they are located on the after half of the ship, they are identified by the word "quarter" instead of "bow." The final line in a standard six-line configuration is called the *stern line*. Like the bow line, this line is usually rigged as a breast line, meaning that it runs perpendicular (or nearly so) to the pier and is used to prevent lateral (in and out) movement of the ship in relation to the pier. Larger ships will, of course, rig more lines to secure the ship more effectively to the pier or another ship. Those rigged in the middle (amidships) of the ship are called *waist* lines. So an extra line rigged amidships to keep the ship snug to the pier, for example, would be called a *waist breast* line. If more lines are rigged, they still follow the rule of numbering from forward, so that the last line aft on a ship moored with eleven lines would be called "number 11."

Once the ship is settled into her berth and all mooring lines have been rigged, they are usually *doubled up*. This is a somewhat misleading term because the way doubling up is actually accomplished results in *three* lines (actually *parts*) going from the ship to the pier instead of just one at each location.

Line-Handling Commands

During the process of mooring a vessel, it is vital that the conning officer be able to communicate efficiently with the line handlers. To

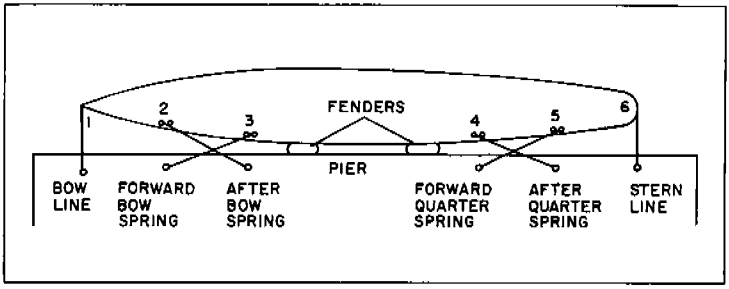


Figure 19.6. A six-line moor. Note the fenders used to keep the ship from rubbing against the pier.

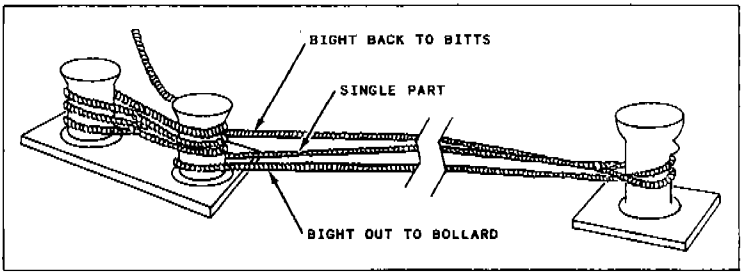


Figure 19.7. Correct method of doubling up.

make sure there is no confusion, commands that are commonly used in mooring operations have been standardized. This system can only be efficient if *both* the conning officer and the line handlers know what the various commands are and what they mean. (See Table 19.1.)

Mooring to a Buoy

There are, in some locations in the world, special buoys that are securely attached to the bottom and are equipped for mooring a ship. Rather than use lines in this type of moor, the ship detaches its anchor chain from its anchor and then reattaches the chain to the buoy. This method has the advantage of allowing a ship to be securely moored in a specific location without having to use its own anchor or its mooring lines. The disadvantage is that, like anchoring, this method of mooring leaves the ship out in the middle of the water, necessitating the use of boats to get personnel and supplies on and off the ship. This method of mooring is not as common as it once was but is still used in some ports.

Anchoring

Mooring to a pier is nearly always the preferred method for a ship to spend its time when not underway. When alongside a pier, personnel can come and go without much difficulty and supplies are easily brought aboard. Because there are not always piers available, and because there are occasions when it is preferable not to be alongside a pier (such as when political unrest in a region makes defending the ship from terrorist attack a priority), ships have the ability to use anchors as an alternative to mooring alongside a pier.

When anchored, boats must be used for transporting personnel and supplies to and from the ship. A careful watch on the sea and weather

Table 19.1. Line-Handling Commands

Command	*Meaning*
Stand by your lines	Man the lines; be ready to cast off or take in.
Pass number one.	Pass the number-one line to the pier and place the eye over the appropriate bollard or other fitting, but take no strain.
Take a strain on number two.	Put number two line under tension.
Slack number four.	Let all tension off the number four line.
Ease the bow line.	Let most of the tension off the bow line.
Hold number six.	Do not let the number six line pay out at all. (Best accomplished by taking turns around a cleat or set of bitts so that the line can't slip.)
Check the stern line.	Do not pay out the stern line but let it slip rather than part the line.
Heave around on number one.	Pull in the number one line using the capstan (mechanical device that can be used to efficiently pull in a line.)
Avast heaving.	Stop the capstan.
Take in number three.	Retrieve the number three line. (Bring your line back aboard your ship.)
Cast off number five.	Take the number five off the bollard or the fitting and let it go. (This command is used to tell line handlers on the pier or on an adjacent ship to return the number five line to the ship it belongs to.)

conditions must be kept and care must exercised to ensure that the ship does begin to move out of its anchorage by dragging its anchor.

The equipment associated with anchoring is called *ground tackle.* This includes the anchors themselves, the chains used to attach them to the ship, the windlasses used to lift the anchor back on board, and a variety of other components, such as shackles, chain stoppers, anchor bars, and detachable links.

Anchors

An anchor is a type of hook that embeds itself into the sea bottom to hold a ship in place. While the anchor itself is an important component of the process, the chain is also vital. The amount of chain used is very important because too much chain will allow the ship to move around too much within its anchorage, and too little may allow the ship to move out of its anchorage by dragging its anchor.

The *shank* is the body of the anchor and the *flukes* are the "teeth" (or hook part) that actually bite into the bottom. Some anchors have a *stock*, which is a kind of crossbar that prevents the anchor from flipping over once it is lying on the bottom.

Anchors are stored in a special tube called a *hawsepipe*. This tube also serves as a passage for the anchor chain that leads from the forecastle deck to the outer surface of the ship's hull closer to the water. The anchor chain is stowed in a large compartment called the *chain locker*.

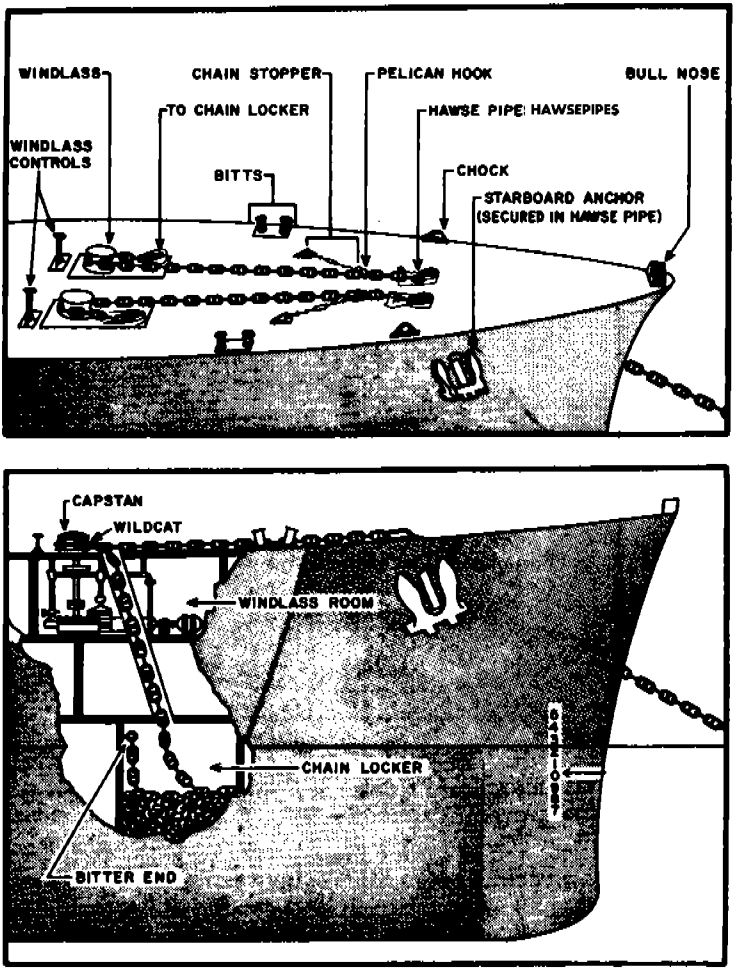


Figure 19.8. A typical ground-tackle arrangement.

There are various types of anchors and different methods of anchoring. The most common method of anchoring is to drop one or two anchors in relatively shallow water and pay out enough chain to ensure that the ship will stay in place. In a *Mediterranean moor,* a ship usually has the stern moored to a pier and an anchor out on each bow. An anchor carried aft by amphibious ships (that deliberately run aground in order to offload troops and supplies) to pull themselves

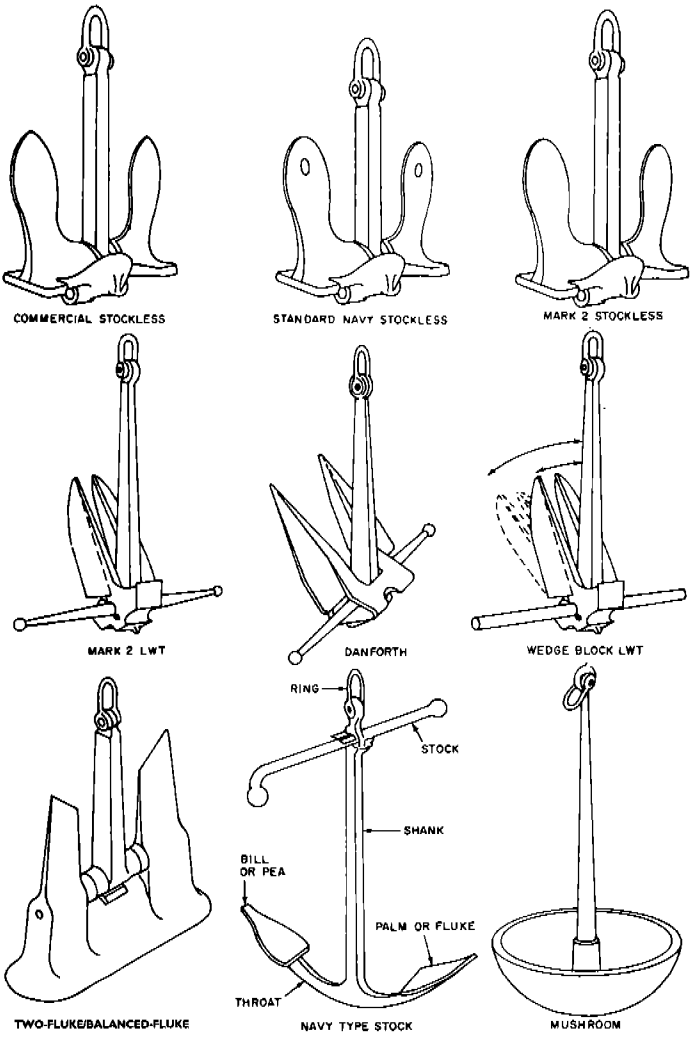


Figure 19.9. Types of anchors.

off the beach (retract) is called a *stern anchor*. A *stream anchor*, now seldom used, is a small anchor dropped off the stern or quarter of a ship to prevent her from swinging to a current.

Stockless anchors, because they do not have the crossbar to get in the way, are easy to stow and were adopted by the Navy for this reason, despite the fact that they do not have the holding power of old-fashioned anchors. Three types of stockless anchors are in use on naval ships: commercial, Mark 2, and standard Navy stockless. Of the three, the Mark 2, with its long flukes, has the greatest holding power. It is made only in the 60,000-pound size for use aboard aircraft carriers.

Mushroom anchors, once used in older submarines, are not used much anymore. They are very useful for placing buoys because, once planted (particularly in groups of three), they are not easily dislodged and are therefore very reliable.

There are three types of *lightweight* (LWT) anchors used on Navy ships. The Mark 2 LWT and the wedge-block LWT are the most common but the commercially made Danforth anchor is also used aboard some Navy craft and small boats. LWT-type anchors have a great deal of holding power for their weights, relying on their ability to dig in rather than their dead weight (as is the case for the stockless types). For example, in a sand bottom, 10,000-pound LWT anchors are designed to have a holding power approximately equal to the 22,500-pound standard Navy stockless. Sizes below 150 pounds are used as boat anchors.

Two-fluke/balanced-fluke anchors are used by surface ships and the newest submarines. They are normally housed in the bottom of the ship rather than in a hawsepipe on the forecastle. In surface ships, they are used in place of bow anchors, which could strike the large, bulbous sonar dome that bulges out beneath the water.

Although no longer used for practical purposes, *old-fashioned anchors* are the traditional anchors you see represented on officers' and chief petty officers' caps and on the rating badges of boatswain's mates. Also known as Navy type Stock anchors, they are commonly used as decorative items in front of Navy buildings and in various other locations.

Ground Tackle

Besides the anchors, there are other important components used in the anchoring process. Chains are the most obvious but there are a number of other components with which you should be familiar if you are going to understand the anchoring process.

Chains

Made of steel, Navy anchor chains vary in size according to the size of the ship and her anchors. Chain comes in 15-fathom lengths called *shots*. To understand this, you need to know that a fathom equals six feet. This means that a shot of anchor chain is 90 feet long. How many shots of chain a ship will carry depends upon the type of ship. Shots are connected to one another by *detachable links*.

A special color-coding system is used to identify the various shots so that when the ship is anchored, you can tell, just by looking at visible chain on deck, how much chain has been payed out and is underwater. Each of the detachable links that marks the beginning of another shot of chain is painted either red, white, or blue. The links on either side are painted white (the number of links corresponding to the number of shots) and pieces of wire are also twisted onto the last white link to further aid in identification (the latter is useful in the dark when you cannot see the links clearly but can feel the turns of wire). Every link in the last shot of chain is painted red and every link in the next-to-last shot is painted yellow. This will give you warning that you are almost out of chain. (See Table 19.2.)

Shackles

In ground tackle, these U-shaped or oval rings are used to attach chains to other objects. For example, the *bending shackle* attaches the anchor chain to the anchor.

Outboard Swivel Shots

On most ships, standard outboard swivel shots, also called *bending shots*, attach the anchor chain to the anchor. They make it possible to stop off (secure) the anchor and break (unfasten) the chain between

Table 19.2. Color-coding System for Shots of Chain

Shot Number	*Color of Detachable Link*	*Number of Adjacent Links Painted White*	*Turns of Wire on Last White Links*
1 (15 fathoms)	Red	1	1
2 (30 fathoms)	White	2	2
3 (45 fathoms)	Blue	3	3
4 (60 fathoms)	Red	4	4
5 (75 fathoms)	White	5	5
6 (90 fathoms)	Blue	6	6

the windlass and the anchor so that the chain can then be attached to a mooring buoy. Outboard swivel shots consist of detachable links, regular chain links, a swivel, an end link, and a bending shackle (which actually attaches the anchor to the chain). Outboard swivel shots vary in length depending upon the size and type of ship but will not normally exceed 15 fathoms.

Chain Stoppers

To hold the anchor securely in place when you are not actually in the process of letting it go or heaving it in, chain stoppers are attached to it. These consist of a *shackle* at one end (attaches the stopper to the deck of the ship) and a *pelican hook* (special hook that fits over a chain and can be securely closed—clamped on—or opened as needed) at the other. Several links of chain are included to give the stopper the desired length and a *turn-buckle* is included that is used to adjust the stopper so that there is no slack in the chain once the stopper is attached (in other words, it makes the stopper taut). The stopper located closest to the hawsepipe is called the *housing stopper*. Other stoppers are called *riding stoppers*.

Stoppers are used for holding the anchor taut in the hawsepipe when not in use, for keeping the chain secure when the ship is riding to an anchor, and for holding an anchor in place when it is disconnected from the chain.

Anchor Windlass

This machine is used to hoist the bow anchor. Those ships with stern anchors have a similar device on the ship's fantail called the *stern-anchor winch.*

On combatant ships, the anchor windlass is a vertical type with controls, including a friction-brake handwheel that can be used to slow down and actually stop the anchor from running out any further once it has been let go (dropped). Below deck is the drive motor with

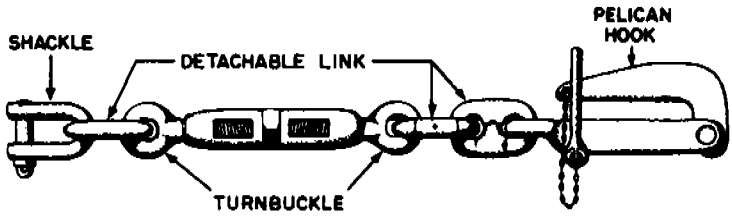


Figure 19.10. A chain stopper.

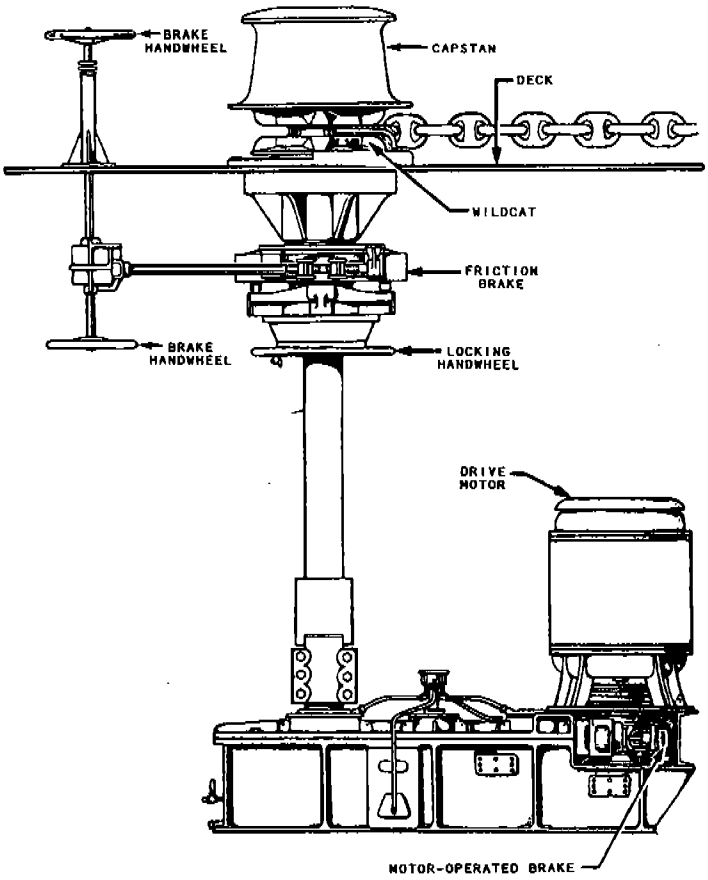


Figure 19.11. Vertical shaft anchor windlass.

its electric and hydraulic components. Above deck is a smooth cylinder called a *capstan* which can use the motor power to heave around on mooring lines. Beneath the capstan is a *wildcat* which is fitted with ridges called *whelps,* which engage the links of the chain and prevent it from slipping while heaving it in. The wildcat may be disengaged from the shaft so that it turns freely when the anchor is dropped; as mentioned before, it is fitted with a brake to stop the chain at the desired length (called *scope*).

On auxiliary ships, the anchor windlass is often a horizontal type above deck, with two wildcats, one for each anchor.

Mooring Shackles

As mentioned earlier, if mooring buoys are available the anchor chain may be detached from its anchor (leaving the anchor secured in its hawsepipe by the stoppers) and then attached to a mooring buoy. Mooring shackles are used to make the attachment. Forged-steel *mooring swivels* with two links of regular chain at each end are inserted into the chain outboard of the hawsepipe to keep the chain from twisting as the ship swings.

The Anchor Detail

The anchor detail is normally headed by the first lieutenant, who is assisted by one or more experienced boatswain's mates and a team of Sailors who can perform the various tasks associated with anchoring.

Whenever a ship is entering or leaving port, the anchor detail is set. This is true even if the ship has no intention of anchoring, because the ship's anchors can be used in an emergency situation to keep the ship from getting into serious danger—they serve as a kind of emergency brake. For example, a ship coming into or leaving a port often must travel through fairly restricted waters (such as a narrow channel or into a small mooring basin). If the ship should suddenly lose its propulsion power, it might coast or drift into danger (such as running aground or colliding with other ships moored or anchored nearby). If the anchors are ready for letting go, they can be dropped and used to hold the ship in place temporarily until the problem can be fixed and propulsion restored.

Dropping the Anchor

With the anchor detail manned, the ship is carefully navigated into position by the OOD and his or her special sea (navigational) detail. When the ship is nearing the anchorage the bridge tells the forecastle to stand by. Personnel on the forecastle will release all but one of the chain stoppers and the windlass brake so that the weight of the anchor is on the chain, which will then be held by the one remaining stopper. When the ship is precisely in position, the bridge will tell the forecastle to let go the anchor. With everyone standing clear of the chain, a Sailor will knock the pelican hook on the stopper loose and, with a great roar, the anchor will plunge into the water and fall to the bottom. Allowing an anchor or its chain to run out using its own weight is called *veering*.

The Sailor controlling the windlass will set the brake soon after the anchor strikes bottom to prevent the chain from piling up. The OOD will normally back the ship down to set the anchor (cause the

flukes to dig into the bottom). Then the OOD will order the brake released on the windlass and will back the ship down some more to veer more chain until it is at the desired scope (length). Stoppers will then be set and the ship is anchored.

Weighing Anchor

When the ship is ready to get underway from its anchorage, the sea and anchor details are set and the forecastle detail will set the brake on the windlass and remove the stoppers. Upon command from the bridge, the windlass operator will begin heaving around to bring in the chain. Normally, she or he will heave around to *short stay* (all the chain is retrieved leading up to the anchor, but heaving is stopped just short of pulling the anchor out of the ground) and wait for orders to proceed.

When so ordered, heaving is continued, and the bridge is informed when the anchor is *up and down* (pulled out of the ground, but still resting on the bottom). Once the anchor is clear of the bottom (the weight of the anchor is on the chain), the report "Anchor's aweigh" is sent to the bridge. At this point the ship is officially underway.

A hose team will spray the chain as it emerges from the water to remove the mud and debris accumulated from the bottom. Once the anchor can be seen, the forecastle will report its condition to the bridge. If it is ready to be housed (brought back into the hawsepipe), it will be heaved in and stoppers will be set to hold it in place.

Standard Commands

Just as it is vital for clear, concise communications during line-handling operations, so is it important to have the same during anchoring operations. (See Table 19.3.)

Scope of Chain

The ship is held in place not only by the anchor itself but by the chain as well. *Scope* is the amount of chain the ship puts out to hold the ship in place. This amount varies with the depth of the water. The scope is normally five to seven times the depth of the water. For example, if your ship is anchoring in 10 fathoms (60 feet) of water, the OOD will use between 50 fathoms (300 feet) and 70 fathoms (420 feet) of chain to hold the ship in place.

Towing

Most routine towing jobs in the Navy are handled by special vessels that are specially equipped to handle these operations, such as harbor

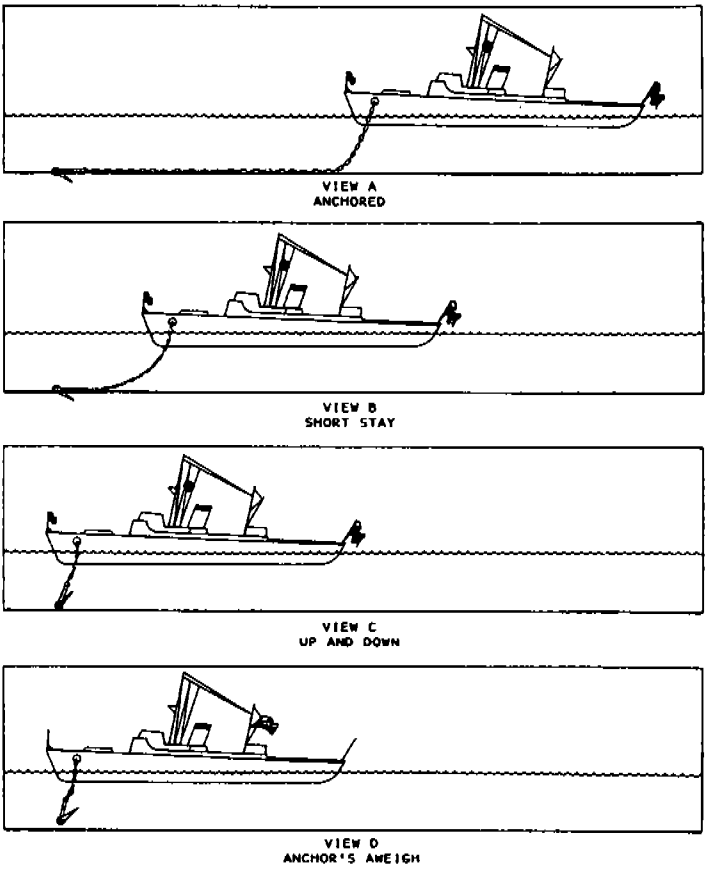


Figure 19.12. From anchored to underway.

tugs, fleet tugs, salvage vessels, and submarine-rescue vessels. But other Navy ships must, in emergencies, be able to tow other vessels or be towed themselves.

The towing rig used varies among classes and types of ships, but includes certain common items in one form or another. On the stern, most ships have a *towing-pad eye* which is used to attach the *towing assembly,* made up of a large pelican hook made fast to a towing hawser. The hawser itself is usually a wire rope varying in length from 100 fathoms for a destroyer to 150 fathoms for a larger ship. It is normally attached to one of the towed ship's anchor chains, which has been disconnected from the anchor, run through the bull-nose, and veered to 20 to 45 fathoms.

Table 19.3. Anchoring Commands

Command	*Meaning*
Stand by.	Brake is released on the windlass so that the weight of the anchor is on the chain stopper
Let go.	The pin is removed from the pelican hook and a Sailor with a maul knocks the bail loose on the pelican hook so that it will release the stopper and the chain can run freely.
Pass the stoppers.	With the brake set, the stoppers are fastened around the chain to hold it in place, then the brake is released.
Heave around to.	The windlass brings the chain in until the short stay anchor is just about to break ground.
Anchor's up and down.	The anchor has broken ground but is still resting on the bottom.
Anchor's aweigh.	The anchor is clear of the bottom and the ship is under way.
Anchor is in sight.	The anchor detail on the forecastle can see the anchor well enough to report its condition.
Anchor is clear.	There is little or no debris from the bottom clinging to the anchor.
Anchor is shod.	The anchor is caked with mud and/or other debris from the bottom.
Anchor is fouled.	The anchor has hooked onto a cable or some other underwater obstruction that will prevent it from being brought into the hawsepipe.

The length of the towline—hawser and chain—is adjusted to hang in a deep underwater curve called a *catenary,* which helps to relieve surges on the line caused by movements of the two ships. Whether towing is done with two motor launches or two cruisers, the towline should be of such a scope (or length) that the two craft are *in step,* which means that they should both reach the crest of a wave at the same time. Otherwise, the towline will be whipped out of the water and may cause serious damage.

Once the towing hawser is rigged, the towing vessel gets under way very slowly. If the towing vessel moves too quickly, it may cause the line to part. Course changes must also be made slowly.

If you are involved in a towing operation, be aware that the towing line could part at any time and that, if it does, the potential for serious injury is very great. Never get any closer to a towing line than you have to.

Deck Seamanship

Despite all of their sophisticated electronics and modern engineering components, Navy ships must still rely on basic deck seamanship techniques to be able to move heavy loads about and to receive fuel, ammunition, and supplies on board. The principles—and, in fact, some of the actual equipment—used to accomplish these things are the same that Sailors have used for centuries. Mechanical winches may have replaced pure manpower in some cases, but the techniques and the rigs used are the same ones that Sailors used in the days of sail to get their work done. Because of this strong link to the past, many of the terms used in deck seamanship come down to us from centuries ago and will, therefore, take some getting used to.

Cargo Handling

Service and amphibious ships in the Navy, by the nature of their business, must be able to handle large amounts of cargo. But even combatants must be able to handle at least limited amounts. Therefore all ships have at least some cargo-handling equipment.

Basic Terminology

The most basic form of a cargo-handling rig is a boom attached to a kingpost that is operated by a combination of lines rigged for the purpose. A *kingpost* is a short, sturdy mast capable of supporting a large amount of weight. A *boom* is a sturdy pole that is attached to the king post by a swivel-type device called a *gooseneck.* The boom is lifted up and down by a *topping lift* and it is moved from side to side by *guys* (sometimes called *vangs*).

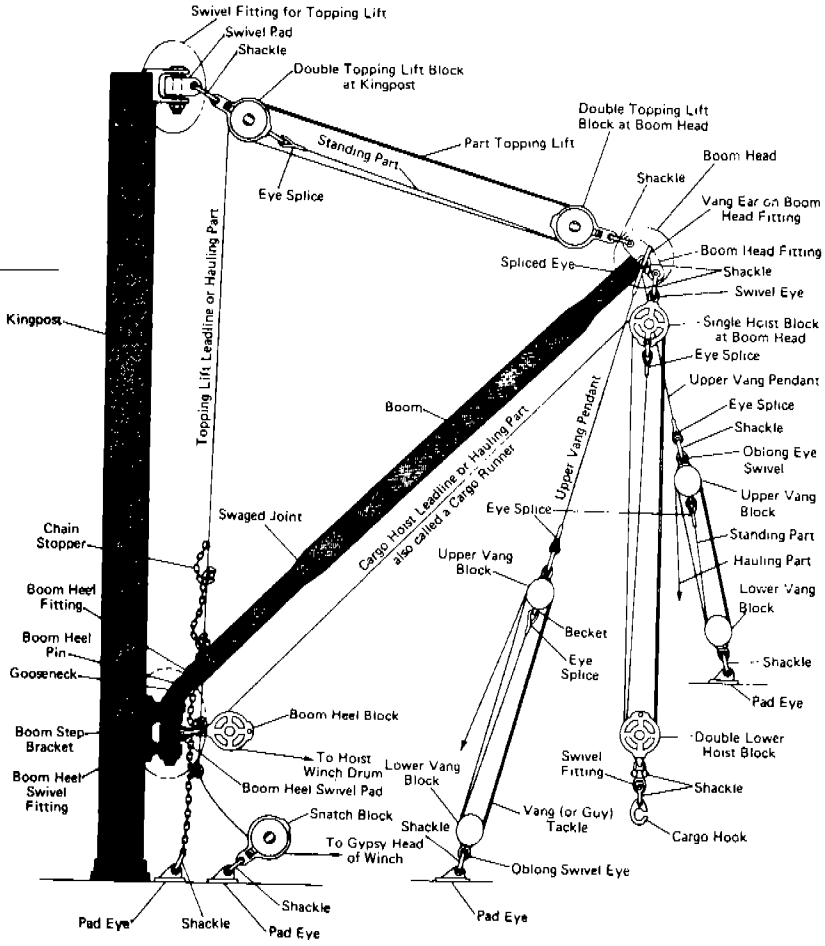
Rigging is a general term for wires, ropes, and chains used to support kingposts or other masts, or to operate cargo-handling equipment. *Standing rigging* describes lines that support but do not move. Examples of standing rigging are *stays,* which are rigged fore and aft to support masts, and *shrouds,* which are rigged athwartships to provide support. *Running rigging* includes movable lines such as topping lifts and guys.

Mechanical Advantage

One of the basic principles you must know if you are going to be able to work efficiently in handling cargo is that a device you probably would have called a pulley before becoming a Sailor is called a *block* and can be rigged to give you a significant mechanical advantage and thereby save you a great deal of work and energy.

When blocks and lines are combined either to change the direction of an applied force or to gain a mechanical advantage, the combination is called a *tackle*. The simplest tackle is called a *single whip* and is made by running one line through one block that has been attached to something (such as the end of a boom). This tackle give you no mechanical advantage and is used solely to cause a change of direction in the force applied; for example, it allows you to lift a load straight up while you are pulling downward.

Figure 19.13. Rigging detail for a single swinging boom. The basic elements are the kingpost, boom, gooseneck, topping lift, and vangs (guys).



For obvious reasons, most tackles are rigged to achieve a mechanical advantage. The simplest tackle that provides this advantage is called a *runner*. Like the single whip, it uses only one line and one block, but by attaching the load to the block itself and allowing the block to move instead of attaching it to something, you gain a 2:1 mechanical advantage. (*Note:* In all cases described here, there is a certain amount of work lost because of friction, but the mechanical advantages gained are close enough for us to approximate them for simplicity.) That means that you will be able to lift a 120-pound load by using only 60 pounds of actual force—your load will seem only half as heavy as it actually is.

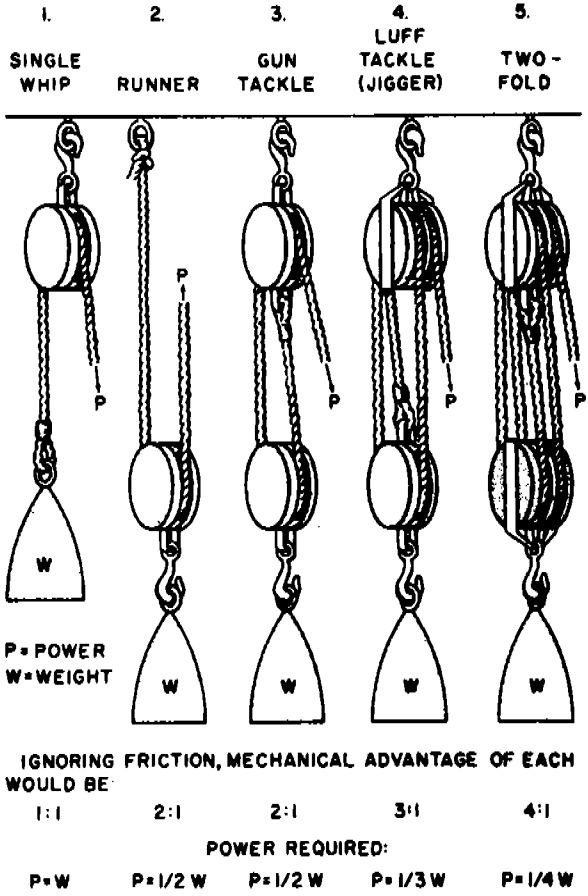


Figure 19.14. Blocks and tackles.

If you think about it, you can see that a runner would not be a very easy tackle to use (difficult to control), so a more common way to gain the same 2:1 advantage is to use *two* blocks (one moving and the other fixed) in a rig we call a *gun tackle.*

You have probably noticed that some blocks have more than one *sheave* (the "wheels" inside the block). Using a block with one sheave, combined with a block that has only two, we came up with a new rig called a *luff tackle.* This rig gives you a 3:1 mechanical advantage, which means your 120-pound load can now be lifted with only 40 pounds of force (it seems to weigh only one-third as much now).

Taking it another step, two blocks with two sheaves each can be rigged into a tackle we call a *twofold.* As you might have guessed, this rig provides an advantage of 4:1, meaning that you need only apply 30 pounds of force to lift your 120-pound load.

You may have noticed a pattern here that will help you to determine the theoretical mechanical advantage of a rig without having to come back to this book to look it up. If you look at the number of lines that are going in and out of the *moving* (not the fixed) block, it will tell you the mechanical advantage. For example, look at both the runner and the gun tackle. The number of lines running in and out of the moving block is two. This means the mechanical advantage is 2:1. The number of lines running in and out of the moving block on the twofold is four, so the mechanical advantage is 4:1.

Still more sheaves can be used in a two-block rig to gain even more advantage, but the friction factor begins to become sizable as you add more sheaves and lines so that the mechanical advantage is significantly degraded.

Basic Rigs

Perhaps the simplest cargo-handling rig is called a *single swinging boom.* If you have ever watched a crane at a construction site, this is comparable to a single swinging boom. The mechanical advantage of this rig can be increased by using one of the block-and-tackle combinations described above.

Booms can be used singly or in pairs. One common use of a pair of booms is the *yard-and-stay* rig. One boom, called the *hatch boom,* is positioned over the ship's deck or over a cargo hatch and the other, called the *yard boom,* is swung out over the side to hang over the pier. The cargo hook is attached to a pair of whips run from the end of each boom. The one attached to the hatch boom is called the *hatch whip* and the one attached to the yard boom is called a *yard whip.* By alter-

nately easing out and heaving around on the two whips, the cargo hook (with its cargo attached) can be moved from the pier to the ship or vice versa.

Underway Replenishment (UNREP)

Before the techniques of underway replenishment (UNREP) were developed, a ship that ran low on fuel, supplies, or ammunition had to return to port, or she had to stop and lie to while she was replenished by small boats. This was a serious handicap that severely limited the effectiveness of ships at sea. With modern techniques of

Figure 19.15. A yard-and-stay rig.